DOCUMENT RESUME

ED 316 753 CE 054 451

AUTHOR	Nobles, Jack
TITLE	Machine Shop. Module 5: Lathes. Instructor's Guide.
INSTITUTION	Missouri Univ., Columbia. Instructional Materials Lab.
SPONS AGENCY	Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
PUB DATE	89
NOTE	257p.; For related documents, see CE 054 447-454. Document contains colored paper. Student reference and worksheets are included in this document.
AVAILABLE FROM	Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (order no. 70-6175-I: $21.15).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Competency Based Education; Educational Objectives; *Equipment Maintenance; *Machinery Industry; *Machine Tool Operators; *Machine Tools; *Machinists; Measurement Equipment; Occupational Information; *Occupational Safety and Health; Postsecondary Education; Secondary Education; Tool and Die Makers; Trade and Industrial Education
IDENTIFIERS	*Lathes; Missouri

ABSTRACT

This document consists of materials for a 10-unit course on the following topics: (1) types and parts of lathes; (2) lathe accessories, maintenance, and safety; (3) lathe operations and tooling; (4) lathe calculations; (5) lathe taper and thread applications; (6) planning considerations; (7) cutting fluids, lathe center alignment, and lathe gaps; (8) work-holding and set-up; (9) tool-holding set-up and operation; and (10) advanced lathe set-up and operation. The instructor's guide begins with a list of competencies covered in the module, descriptions of the materials included, an explanation of how to use the materials, and information on how the curriculum guide is packaged. Next is a table that associates individual instructional materials in the units with the competencies they teach. The instructional units follow, each of which may include unit objectives, lesson objectives, lesson plans, references, notes to the teacher, information sheets or outlines, transparency masters, handouts, assignment sheets, job sheets, unit tests, and answers to tests. (CML)

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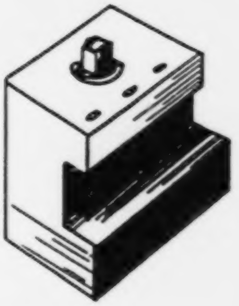
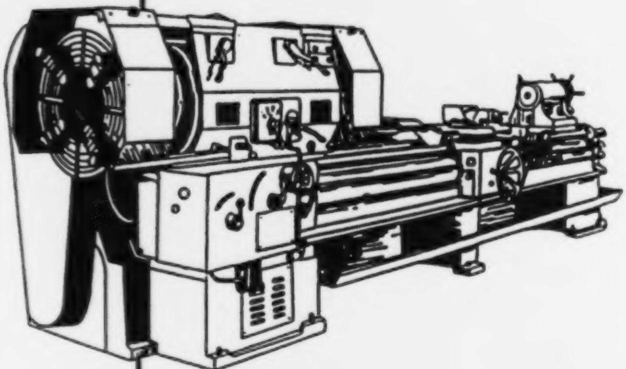
MACHINE [illegible]OP CURRICULUM

INSTRUCTOR'S GUIDE

MODULE 5: **Lathes**





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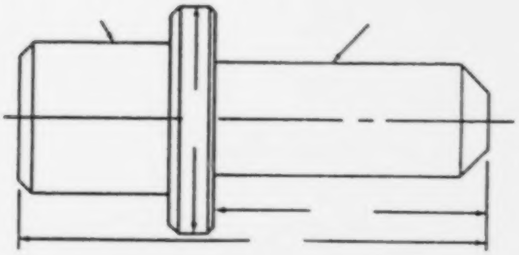

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MACHINE SHOP

Module 5: Lathes

by

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1989

Instructor's Guide
Catalog No. 70-6175-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts and professionalism to develop curriculum for trade, technical and industrial education programs. This Machine Shop guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future machine shop curriculum modifications will begin with this guide. The machine shop field is undergoing considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Moore, supervisor
Industrial Education
Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
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ACKNOWLEDGMENTS

This Machine Shop guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the machine shop competency profile developed by industry and education professionals in the state.

Appreciation is given to the writers (Charlie Walden, Jack Nobles, Dwight Crosswhite, Donna Curtis, Don Marquardt, Bill Daniel, Mel Gage and Jr. Cagle) for their technical expertise. Catherine Smith of Dodge Art Works, Columbia, created a large portion of the guide's artwork.

These industry representatives and educators contributed to the guide as members of the advisory committee.

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Support and contributions of IML staff members were instrumental to this module's development.

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Unit X: Advanced lathe set-up and operation 243

COMPETENCIES ADDRESSED IN THIS MODULE

Blueprint Reading

D9. Plan sequence of machining operations

Introduction to Material Science

F2. List properties that affect machinability
F4. List major cutting tool variables

Operating Lathes

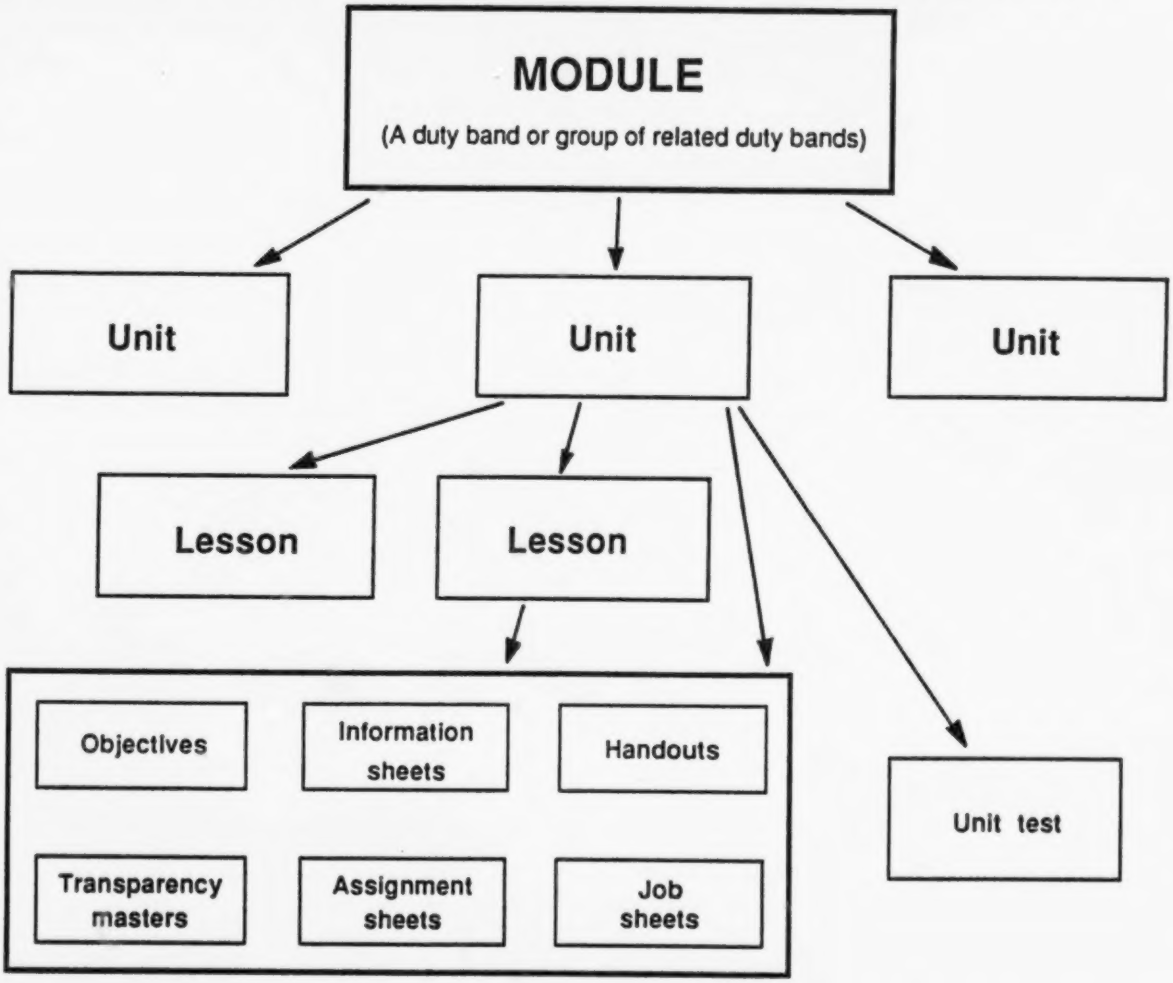
I1. Employ lathe safety guidelines consistently
I2. Perform care and maintenance
I3. Align lathe centers using test bar and dial indicators
I4. Determine cutting tool variables prior to use
I5. Calculate feeds and speeds for lathe set-up
I6. Free-hand grind turning and facing tools
I7. Select and apply cutting fluids
I8. Operate lathe controls
I9. Face workpiece and center drill
I10. Set up tooling
I11. Turn workpiece between centers
I12. Center workpiece in four-jaw chuck
I13. Drill holes
I14. Ream holes
I15. Bore holes
I16. Countersink holes
I17. Counterbore holes
I18. Knurl parts
I19. Free-hand grind 60° threading tool
I20. Cut/chase external threads
I21. Chase/rechase internal threads
I22. Chase metric threads
I23. Use compound rest to cut short external tapered surface
I24. Cut tapers by offset tailstock
I25. Cut an external tapered surface with taper attachment
I26. Cut internal tapered surfaces with taper attachment
I27. Align workpiece on faceplate
I28. Perform lathe filing
I29. Polish workpiece
I30. Turn or thread long workpieces using follower and steady rest
I31. Cut multiple threads
I32. Cut Acme threads
I33. Use form tooling
I34. Use mandrel

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Machine Shop guide contains eight modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section near the beginning of each unit.


MODULE
(A duty band or group of related duty bands)
Unit
Unit
Unit
Lesson
Lesson
Objectives
Information sheets
Handouts
Transparency masters
Assignment sheets
Job sheets
Unit test

Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

3 = **Mastery** - can work independently with no supervision
2 = **Requires supervision** - can perform job completely with limited supervision
1 = **Not mastered** - requires instruction and close supervision
N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, and so on. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives' intent. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage or bodily injury. Handouts and transparency masters have been keyed in the information sheets for instructional use.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and direct the class's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion, however.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Machine Shop guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all eight modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

MODULE 5: LATHES

CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
D9	VI 1.1		VI 1.1	VI 1.1,1.2		VI A1-10,B1-9	
F2	VI 1.2		VI 1.3			VI 15,16	
F4	VI 1.1		VI 1.2			VI 13,14	
I1	II 1.4					II 14-18	
I2	II 1.3				II 1.1		
I3	VII 1.4-1.6				VII 1.2,1.3	VII 5-10	
I4	IV 1.2			IV 1.2		IV 5,10,15,16	
I5	IV 1.1		IV 1.1			IV 1-4,6-9,11-14	
I6	III 2.4,2.5				VII 2.1,2.2	III 11,15	
I7	VII 1.1,1.3				VII 1.1	VII 1-4	
I8	III 2.7				III 2.4		
I9	IX 2.1				IX 2.1		
I10	VI 1.3, IX 1.1-1.3			IX 1.1		VI 11,12	
I11	IX 2.2				IX 2.2		
I12	VIII 1.4-1.5,1.7, IX 2.4				VIII 1.1-1.3, IX 2.3	VIII 1,3-6,8-13	
I13	IX 2.5				IX 2.4		
I14	IX 2.4				IX 2.4		
I15	IX 2.7				IX 2.5		

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
I16	IX 2.9				IX 2.6		
I17	IX 2.3				IX 2.6		
I18	IX 2.8				IX 2.7		
I19	III 2.6				III 2.3	III 1	
I20	X 2.2a				X 2.4		
I21	X 2.2b				X 2.5		
I22	X 2.2c				X 2.6		
I23	X 2.3a				X 2.7		
I24	X 2.3b				X 2.8		
I25	X 2.3c				X 2.9		
I26	X 2.3d				X 2.9		
I27	X 1.4				X 2.2		
I28	X 2.3e				X 2.10		
I29	X 2.3e				X 2.10		
I30	X 1.2,1.3				X 2.1		
I31	X 2.1a				X 2.3,2.4		
I32	X 2.1b				X 2.4		
I33	X 2.3e				X 2.10		
I34	III 1.7, VI 1.3, VIII 1.6				III 1.3	VI 10, VIII 14	In Grinders Unit III, JS 1.3

MODULE: LATHES
UNIT I: TYPES AND PARTS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify types and parts of lathes. This knowledge will be evidenced by achieving the specified score on the assignment sheet and unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms associated with lathes to definitions or illustrations.

1.2 Match types of lathes to uses.

1.3 Identify major parts of an engine lathe.

2.1 Identify parts of the lathe headstock.

2.2 Match headstock parts to uses.

2.3 Identify parts of the lathe carriage.

2.4 Match carriage parts to uses.

2.5 Identify parts of the lathe tailstock.

2.6 Match tailstock parts to uses.

MODULE: LATHES

UNIT I: TYPES AND PARTS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

  1. Lesson 1: TYPES OF LATHES

    a. Information outline

    b. Transparency master

      TM 1.1: Major parts of an engine lathe

    c. Assignment sheet

      AS 1.1: Lathe types

  2. Lesson 2: LATHE PARTS AND USES

    a. Information outline

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

  1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

  2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

  3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

  4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

  1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

  2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

    a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

    b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

    c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.

    d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

    e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

2. Audiovisual

    a. Introduction to the Lathe, Part I (MS-84-350) (video). Sedalia, MO: State Fair Community College, 1984. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610)

MODULE: LATHES

UNIT I: TYPES AND PARTS

LESSON 1: TYPES OF LATHES

I. Terms and definitions

A. Bill of materials--complete list of all parts, hardware and stock needed to complete a job

NOTE: Cost of each item can be included.

B. Chip breaker--groove ground near cutting edge that causes chip to break instead of flowing as a continuous ribbon

C. Crater resistance--ability to resist excessive heat wear generated at cutting edge by friction from chips moving over cutting tool

D. Cutting edge--part that cuts as tool is advanced into work

E. Cutting-edge angle--slant of cutting edge in relation to tool shank

F. Cutting speed--rate at which cutting edge moves along surface of work; expressed in surface feet per minute (sfpm)

G. Disposable inserts--cutting tools not designed to be sharpened

H. Engine lathe--general term for bench and floor-model lathes with headstock, bed, carriage and tailstock

I. Forming tool--pre-formed tool that cuts the inverse of its form on workpiece

J. Geared-head lathe--lathe with headstock design that uses gear setting to produce a wide range of spindle speeds

K. Screw-cutting lathe--lathe with precisely controlled rate of movement between spindle revolutions and carriage feed

L. Single-point cutting tool--instrument with one cutting edge which removes material from workpiece

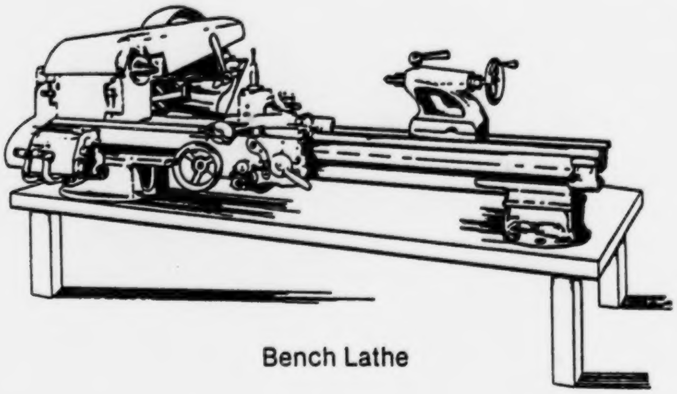
M. Tool life--time period during which a cutting tool maintains its ability to cut efficiently between reconditionings

II. Lathe types and uses

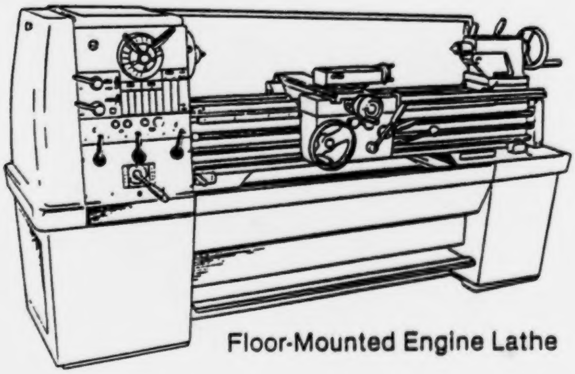
A. Bench lathe--used to produce small parts; usually a precision machine mounted on a bench or table

B. Floor-mounted lathe--used for light production; most common of all engine lathes; several sizes available

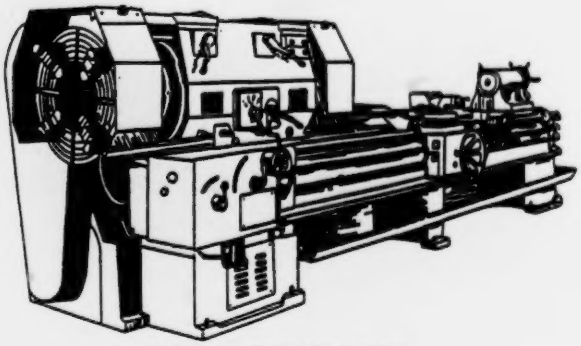
Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 147-161.



Bench Lathe

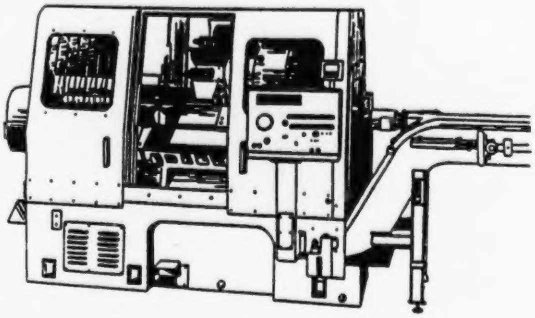


Floor-Mounted Engine Lathe

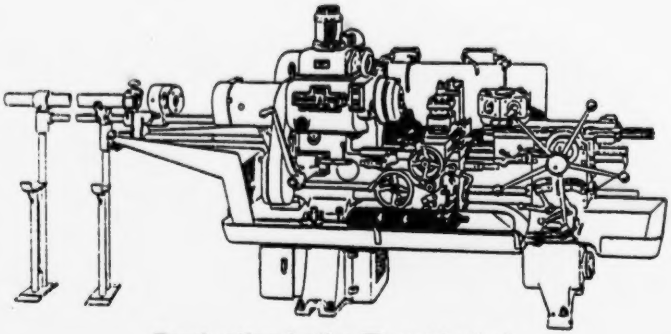


Hollow Spindle Lathe

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 147-161.

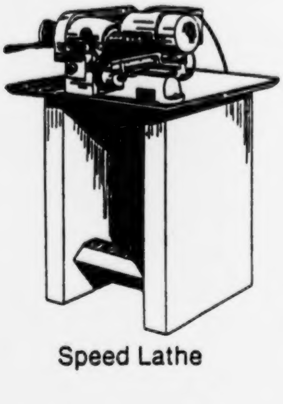


Numerical Control Lathe

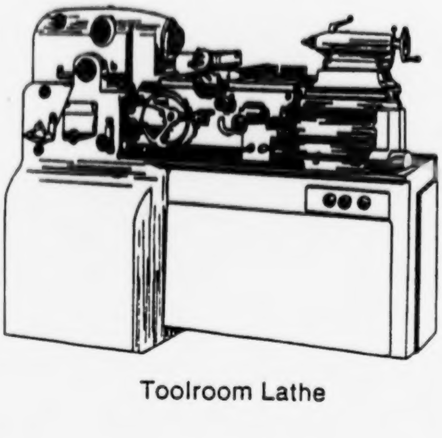


Production Lathe (Turret Lathe)

Credit: Adapted with permission of the Warner & Swasey Company



Speed Lathe



Toolroom Lathe

C. Hollow-spindle lathe--designed primarily for oil field industry; large hole through spindle holds lengthy, large-diameter work

D. Numerical-control lathe--production machine controlled by tape or computer; performs many jobs previously done on turret and bar machines

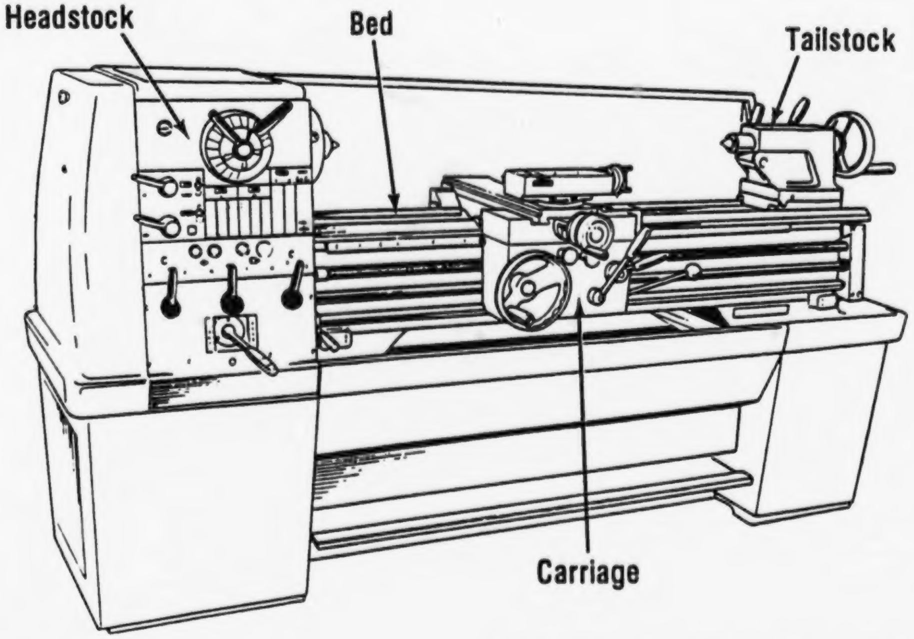
E. Production lathe (turret lathe)--used to produce large numbers of parts; operated manually or semiautomatically

Examples: Screw machines, bar chuckers, vertical turret lathes

F. Speed lathe--small production lathe; also called a second operation lathe

G. Toolroom lathe--small, floor-mounted lathe made for accuracy

III. Major parts of an engine lathe **(TM 1.1)**



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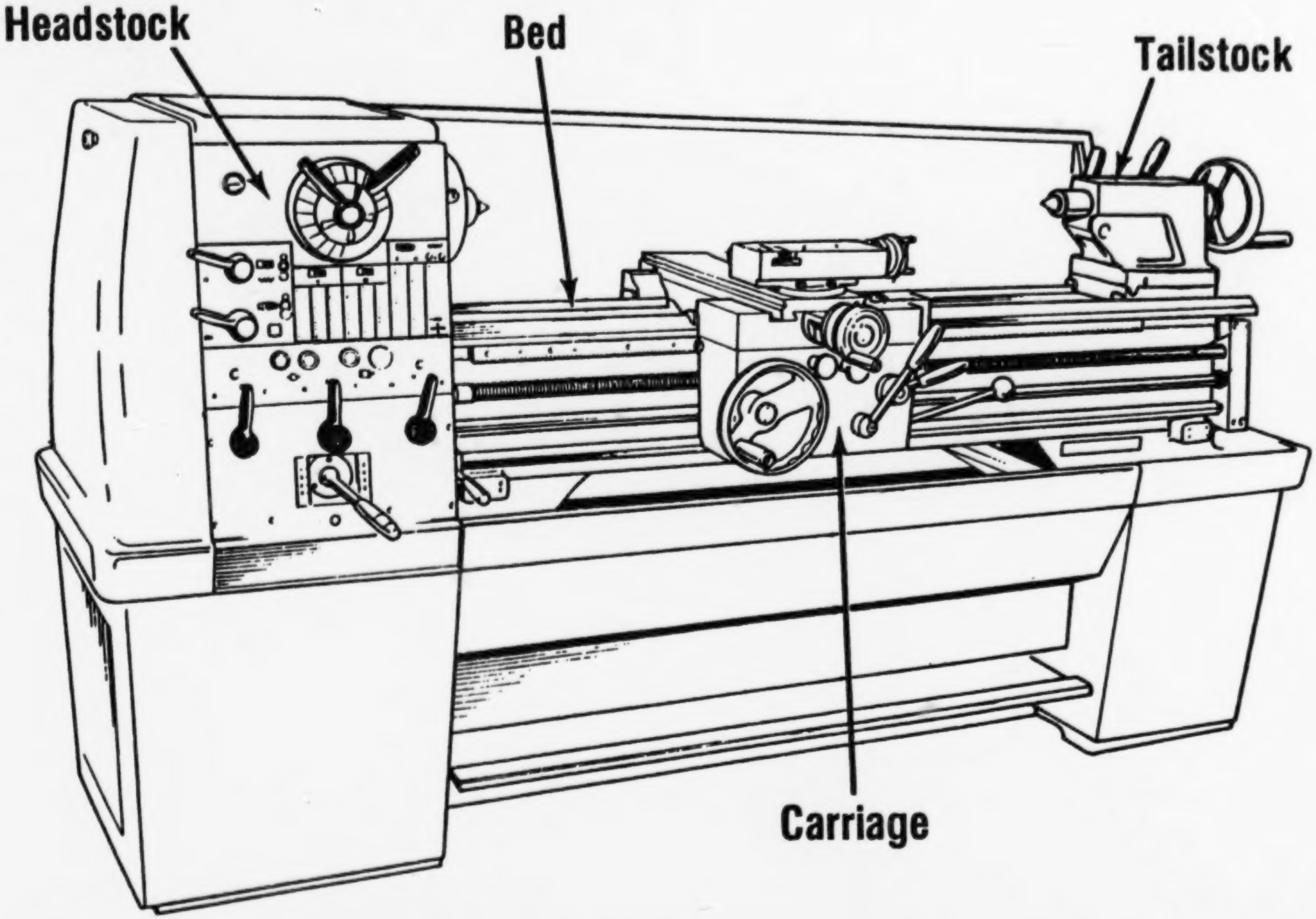
MAJOR PARTS OF AN ENGINE LATHE


Headstock
Bed
Tailstock
Carriage

Credit: Adapted with permission of Clausing Industrial, Inc.,
1819 N. Pitcher Street, Kalamazoo, MI 49007.

AS 1.1

LATHE TYPES

Match terms associated with lathes to definitions.

____ 1. Rate at which cutting edge moves along surface of work; expressed in surface feet per minute

____ 2. Part that cuts as tool is advanced into workpiece

____ 3. General term for bench and floor-model lathes with headstock, bed, carriage and tailstock

____ 4. Groove ground near cutting edge that causes chip to break instead of flowing as a continuous ribbon

____ 5. Complete list of all parts, hardware and materials needed to complete a job

____ 6. Cutting edge slant in relation to tool shank

____ 7. Lathe with headstock design that uses gear setting to produce a wide range of spindle speeds

____ 8. Time period during which a cutting tool maintains ability to cut efficiently between reconditioning

____ 9. Instrument with one cutting edge which removes material from workpiece

____ 10. Cutting tools not designed to be sharpened

____ 11. Lathe with precisely controlled rate of movement between spindle revolutions and carriage feed

____ 12. Ability to resist excessive heat wear generated at cutting edge by friction from chips moving over cutting tool

____ 13. Pre-formed tool that cuts the inverse of its form on workpiece

a. Engine lathe

b. Single-point cutting tool

c. Cutting speed

d. Screw-cutting lathe

e. Tool life

ab. Chip breaker

ac. Crater resistance

ad. Cutting edge

ae. Bill of materials

bc. Disposable inserts

bd. Cutting-edge angle

be. Geared-head lathe

cd. Forming tool

Match the lathe types to uses.

____ 14. Produces large numbers of parts; operated manually or semiautomatically

____ 15. Small, floor-mounted lathe made for accuracy

____ 16. Production machine controlled by tape or computer; performs many jobs previously done on turret and bar machines

____ 17. Produces small parts; usually a precision machine mounted on a bench or table

____ 18. Used for light production; most common of all engine lathes; several sizes available

____ 19. Designed primarily for oil field industry; large hole through spindle holds lengthy, large-diameter work

____ 20. Small production lathe; also called a second operation lathe

a. Numerical-control lathe

b. Toolroom lathe

c. Hollow-spindle lathe

d. Production lathe (turret lathe)

e. Floor-mounted lathe

ab. Bench lathe

ac. Speed lathe

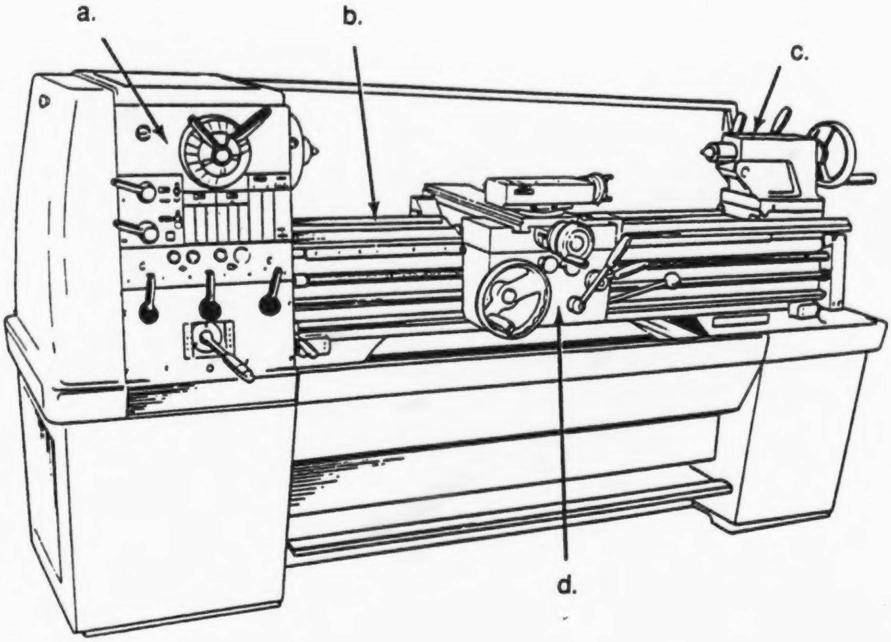
Identify the major parts of the engine lathe below.

____ 21. Headstock

____ 22. Carriage

____ 23. Tailstock

____ 24. Bed



Credit: Adapted with permission of Clausing Industrial, Inc., 1819 N. Pitcher Street, Kalamazoo, MI 49007.

ANSWERS TO AS 1.1

1. c
2. ad
3. a
4. ab
5. ae
6. bd
7. be
8. e
9. b
10. bc
11. d
12. ac
13. cd
14. d
15. b
16. a
17. ab
18. e
19. c
20. ac
21. a
22. d
23. c
24. b

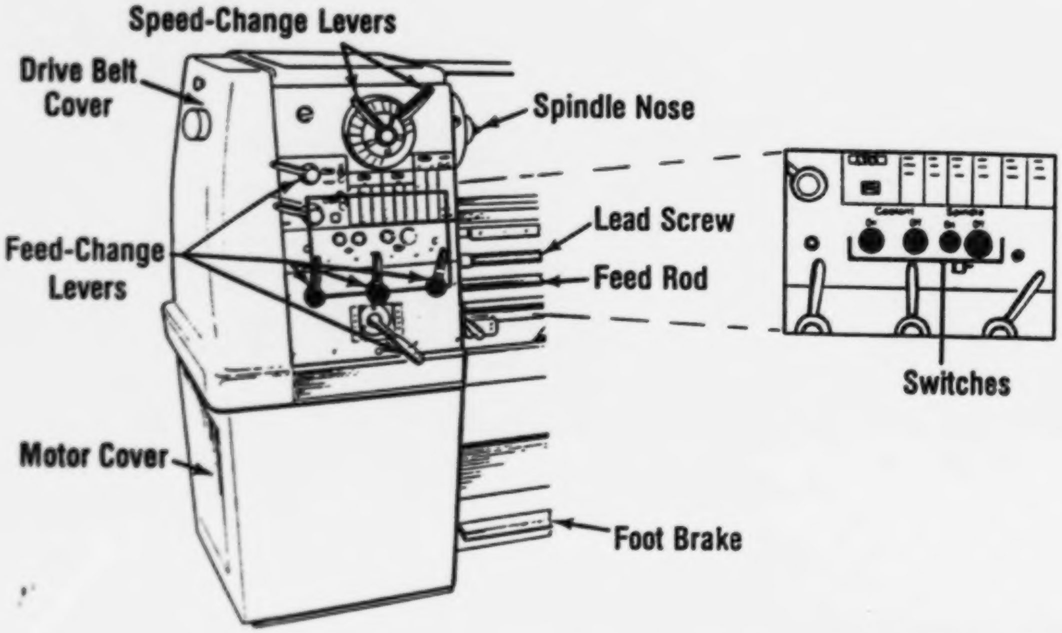
MODULE: LATHES

UNIT I: TYPES AND PARTS

LESSON 2: LATHE PARTS AND USES

I. Major parts and uses of the lathe headstock

A. Parts


Speed-Change Levers
Drive Belt Cover
Spindle Nose
Lead Screw
Feed-Change Levers
Feed Rod
Switches
Motor Cover
Foot Brake

Credit: Adapted with permission of Clausing Industrial, Inc., 1819 N. Pitcher Street, Kalamazoo, MI 49007.

B. Uses

1. Speed-change levers regulate revolutions per minute that the spindle turns.

2. The spindle nose is the part on which work-holding devices are mounted. The design of this driving and mounting device will vary with different manufacturers; however, the three major types are key-drive taper spindle, cam-lock spindle and threaded spindle.

3. The lead screw receives movement from headstock and transmits power to carriage. If the lathe has a feed rod, the lead screw is used only when threading and cutting leads.

4. The feed rod receives movement from the headstock and transmits power to the carriage for movement of longitudinal and cross feeds.

   NOTE: Some lathes use the lead screw with a keyway to obtain power feed movements.

5. The foot brake is a safety feature which disengages the clutch and applies brake to stop machine in an emergency.

6. Motor covers are protective guards for the motor, pump and pulleys.

7. Feed-change levers determine amount of feed per spindle revolution.

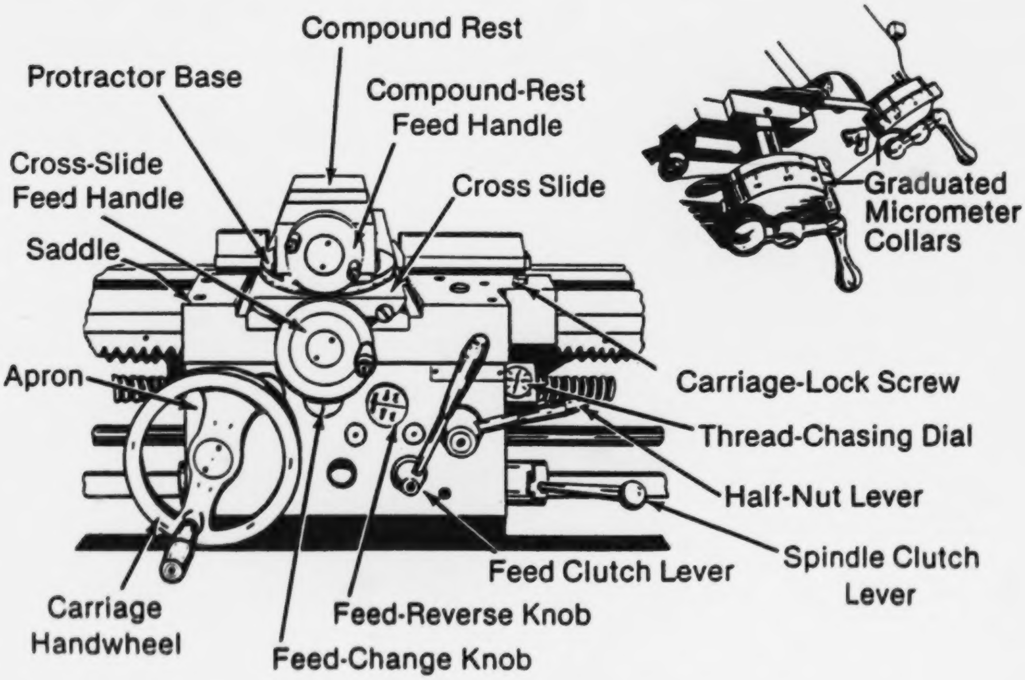
8. Drive belt covers are protective guards for drive belts.

9. Switches control power to main motor and coolant pump.

CAUTION: The on and off switches should never be used with the clutch lever engaged; make sure the clutch lever is disengaged before pushing stop button.

II. Parts and uses of the lathe carriage

A. Parts


Compound Rest
Protractor Base
Compound-Rest Feed Handle
Cross-Slide Feed Handle
Cross Slide
Saddle
Graduated Micrometer Collars
Apron
Carriage-Lock Screw
Thread-Chasing Dial
Half-Nut Lever
Spindle Clutch Lever
Feed Clutch Lever
Feed-Reverse Knob
Carriage Handwheel
Feed-Change Knob

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 165.

B. Uses

1. The **compound rest** carries the toolholder and is moved with manual feed only.

2. The **protractor base** allows compound rest movement along any angle.

3. **Cross-slide feed handles** move the cross slide in or out with micrometer accuracy.

4. The **saddle** is an H-shaped casting which slides along the ways and carries cross slide and apron as it moves between headstock and tailstock.

5. The **apron** contains the carriage, cross-slide controls and oil reservoir to lubricate saddle and other gears contained in the housing.

6. The **carriage handwheel** moves the carriage longitudinally; it is connected to a gear that meshes with rack mounted parallel to bed.

7. **Feed-change knobs** select longitudinal feed or cross feed for power carriage movement.

8. **Feed-reverse knobs** select power movement direction of the carriage or cross slide.

9. **Feed clutch levers** engage and disengage carriage power feeds.

10. The **spindle clutch lever** engages and disengages driving mechanism of headstock to produce spindle rotation.

    NOTE: This lever not only turns on the spindle but also reverses direction of spindle rotation.

11. The **half-nut lever** engages and disengages half-nut to lead screw to cut threads.

12. The **thread-chasing dial** revolves with the lead screw to indicate to operator when to engage half-nut lever; it also synchronizes movement of carriage to the lead screw.

13. The **carriage-lock screw** is a mechanical clamp used when performing heavy facing or cutoff operations; it keeps the carriage from moving longitudinally.

14. **Cross slides** carry the compound rest in or out by power or manual feed.

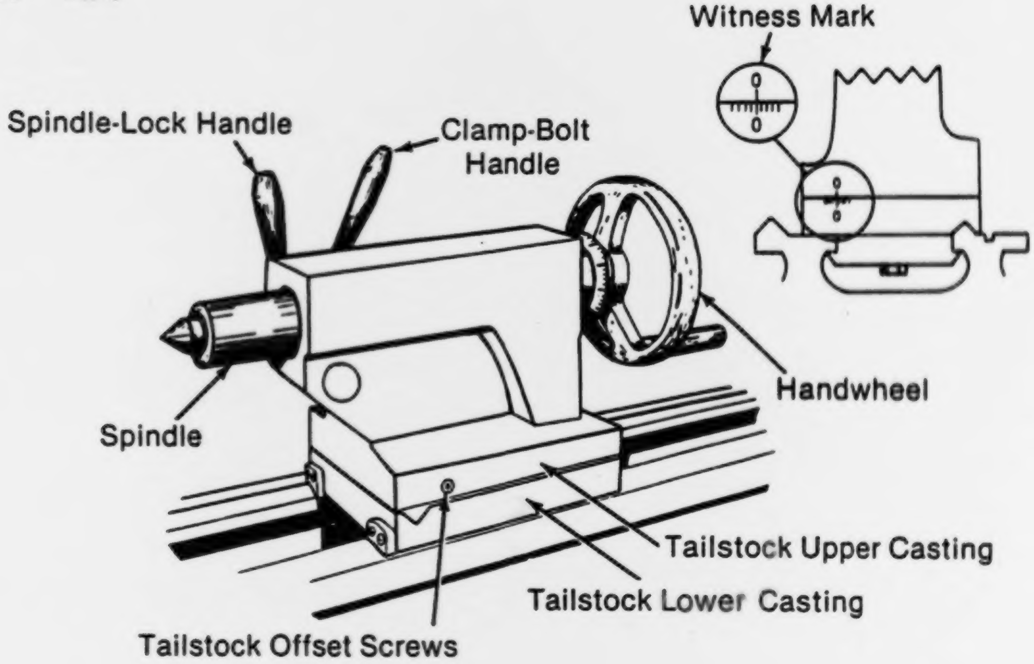
15. The **compound-rest feed handle** feeds the compound rest back and forth in a straight line at angle set by the protractor base of compound.

16. **Graduated micrometer collars** allow compound and cross slide to have measured movement.

    NOTE: Some graduations read direct (1 to 1). Others read 2 to 1--the diameter is reduced 0.002" for every 0.001" of feed.

III. Parts and uses of the lathe tailstock

A. Parts


Witness Mark
0
0
Spindle-Lock Handle
Clamp-Bolt Handle
Handwheel
Spindle
Tailstock Upper Casting
Tailstock Lower Casting
Tailstock Offset Screws

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 167.

B. Uses

1. The spindle-lock handle locks the spindle in place.
2. The clamp-bolt handle engages the clamping mechanism that locks tailstock assembly to head.
3. Handwheels move the spindle in or out of its housing.
4. The tailstock upper casting houses spindle and other parts of the tailstock.
5. The tailstock lower casting provides accurate alignment, supports the upper casting and moves the assembly along its bed
6. Tailstock offset screws align or set tailstock offset.
7. The spindle holds centers, drills, reamers and chucks with Morse tapers, is moved with a handwheel and is graduated for reference.
8. Witness marks indicate tailstock alignment.

MODULE: LATHES

UNIT I: TYPES AND PARTS

UNIT TEST

Identify the major parts of the lathe headstock.

____ 1. Feed rod

____ 2. Switches

____ 3. Feed-change levers

____ 4. Spindle nose

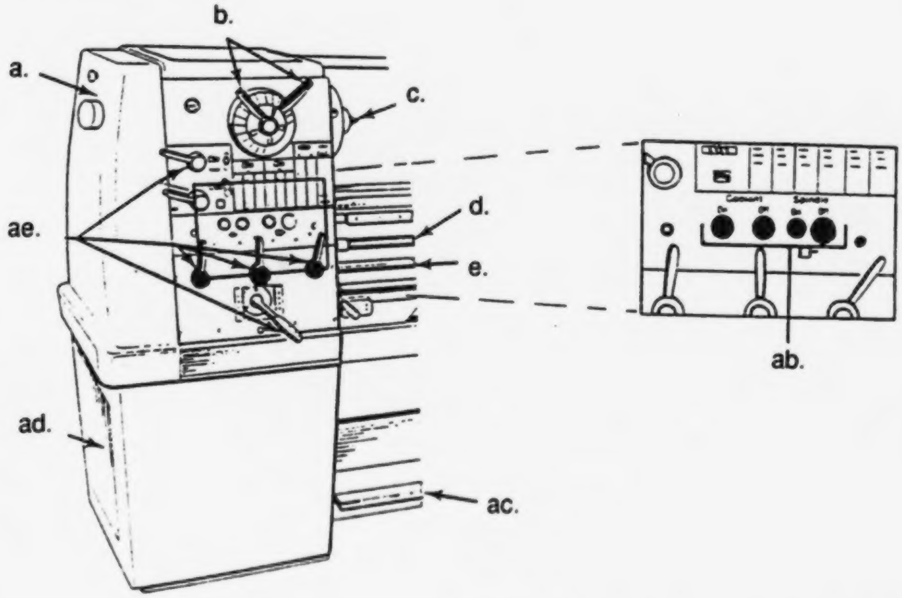
____ 5. Motor cover

____ 6. Foot brake

____ 7 Lead screw

____ 8. Speed-change levers

____ 9. Drive belt cover



Credit: Adapted with permission of Clausing Industrial, Inc., 1819 N. Pitcher Street, Kalamazoo, MI 49007.

Identify parts of the lathe carriage below.

____ 10. Feed-reverse knob

____ 11. Carriage-lock screw

____ 12. Graduated micrometer collars

____ 13. Thread-chasing dial

____ 14. Spindle clutch lever

____ 15. Feed-change knob

____ 16. Apron

____ 17. Protractor base

____ 18. Carriage handwheel

____ 19. Compound rest

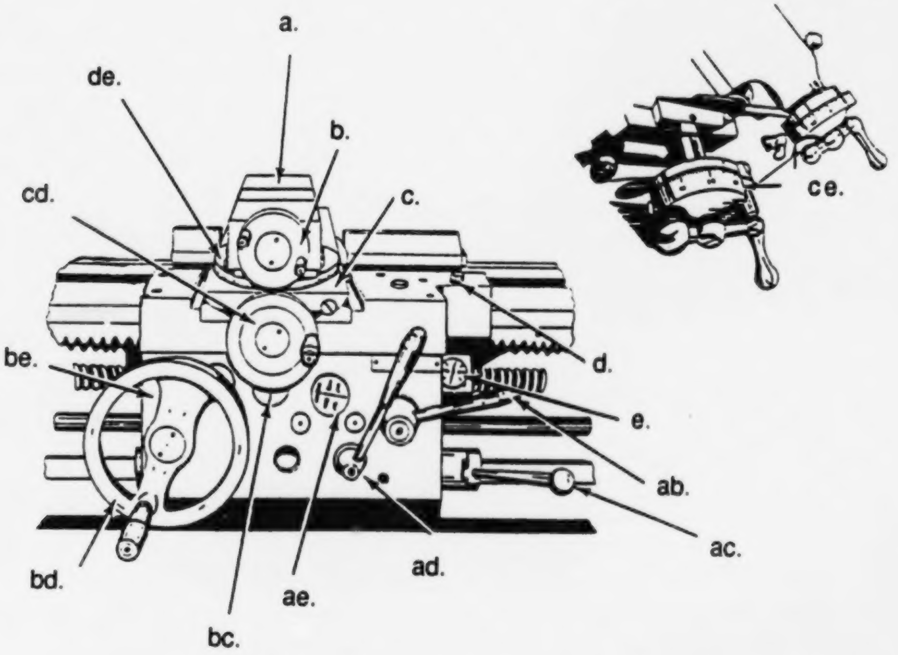
____ 20. Cross-slide feed handle

____ 21. Feed clutch lever

____ 22. Cross slide

____ 23. Compound-rest feed

____ 24. Half-nut lever



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 165.

Match carriage parts to uses.

____ 25. Carries the toolholder and is moved with manual feed only

____ 26. Revolves with lead screw so operator knows when to engage half-nut lever; synchronized movement of carriage to the lead screw

____ 27. Moves cross slide in or out with micrometer accuracy

____ 28. Mechanical clamp used when performing heavy facing or cutoff operations; keeps carriage from moving longitudinally

____ 29. Allows compound rest movement along any angle

____ 30. Contains carriage, cross-slide control and oil reservoir to lubricate saddle and other gears contained in the housing

____ 31. Allow compound and cross slide to have measured movement

____ 32. Selects longitudinal feed or cross feed for power carriage movement

____ 33. Engages and disengages driving mechanism of headstock to produce spindle rotation

____ 34. H-shaped casting which slides along the ways and carries cross slide and apron as it moves between headstock and tailstock

____ 35. Selects power movement direction of carriage or cross slide

____ 36. Moves carriage longitudinally; connected to a gear that meshes with rack mounted parallel to bed

____ 37. Engages and disengages half-nut to lead screw to cut threads

____ 38. Engages and disengages carriage power feeds

____ 39. Feeds compound rest back and forth in a straight line at angle to which protractor base of compound is set

a. Thread-chasing dial

b. Compound-rest feed handle

c. Saddle

d. Feed-reverse knob

e. Compound rest

ab. Apron

ac. Feed-change knob

ad. Carriage-lock screw

ae. Protractor base

bc. Carriage handwheel

bd. Feed clutch lever

be. Spindle clutch lever

cd. Cross-slide feed lever

ce. Half-nut lever

de. Graduated micrometer collars

Match tailstock parts to uses.

____ 40. Locks spindle in place

____ 41. Engages clamping mechanism that locks tailstock assembly to bed

____ 42. Moves spindle in or out of its housing

____ 43. Indicates tailstock alignment

____ 44. Houses spindle and other parts of tailstock

____ 45. Provides accurate alignment, supports upper casting and moves assembly along bed

____ 46. Align or set tailstock offset

____ 47. Holds centers, drills, reamers and chucks with Morse tapers; moved with handwheel; graduated for reference

a. Tailstock offset screws

b. Handwheel

c. Spindle

d. Tailstock lower casting

e. Clamp-bolt handle

ab. Spindle-lock handle

ac. Tailstock upper casting

ad. Witness mark

ANSWERS TO UNIT TEST

1. e
2. ab
3. ae
4. c
5. ad
6. ac
7. d
8. b
9. a
10. ae
11. d
12. ce
13. e
14. ac
15. bc
16. be
17. de
18. bd
19. a
20. cd
21. ad
22. c
23. b
24. ab
25. e
26. a
27. cd
28. ad
29. ae
30. ab
31. de
32. ac
33. be
34. c
35. d
36. bc
37. ce
38. bd
39. b
40. ab
41. e
42. b
43. ad
44. ac
45. d
46. a
47. c

MODULE: LATHES

UNIT II: ACCESSORIES, MAINTENANCE AND SAFETY

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify lathe accessories. The student should also be able to identify safety and maintenance rules when performing lathe work. This knowledge will be evidenced through demonstrations and by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match lathe accessories to applications.

1.2 Identify types of spindle drives.

1.3 Clean and lubricate engine lathe and equipment. (competency I2, JS 1.1)

1.4 Identify rules for the safe use of the engine lathe. (competency I1)

MODULE: LATHES

UNIT II: ACCESSORIES, MAINTENANCE AND SAFETY

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

   1. Lesson 1: ACCESSORIES, MAINTENANCE AND SAFETY

      a. Information outline

      b. Job sheet

         JS 1.1: Clean and lubricate lathe and equipment

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

   1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

   2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

   3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

   4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

   1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

   2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

   3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

   a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

   b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

   c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.

   d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

   e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

2. Audiovisual

   a. Introduction to the Lathe, Part II (MS-84-351) (video). Sedalia, MO: State Fair Community College, 1984. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610)

MODULE: LATHES

UNIT II: ACCESSORIES, MAINTENANCE AND SAFETY

LESSON 1: ACCESSORIES, MAINTENANCE AND SAFETY

I. Applications of lathe accessories

A. Adjustable thread-cutting stop--used as positive stop for crossfeed movement; eliminates need to remember number of revolutions away from work that crossfeed was turned

B. Ball-bearing center--used in tailstock spindle; revolves with work, eliminating friction between work center and lathe center; allows use of higher spindle speeds

C. Bent-tail lathe dog--clamps to round work and transmits power from drive plate to work

D. Clamping lathe dog--used to transmit power from drive plate to work; holds square, rectangular or round work

E. Collet chuck--used for light-duty work on stock that is usually one inch or smaller; available for square, round or hexagonal stock

F. Compound-turret toolholder--allows four tools to be preset; tools can be rotated by loosening lock; excellent for short production runs

G. Drill chuck--used to hold drills or reamers; can be mounted in lathe headstock or tailstock

H. Drive plate (dog plate)--used to transmit power from spindle to work by means of lathe dog; mounted directly to spindle

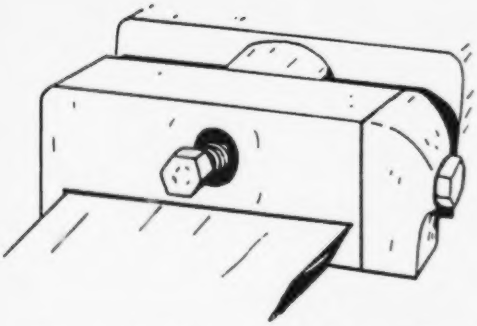
I. Face plate--used to mount work or fixtures by means of bolts and clamps when part cannot be held in a chuck or between centers; often used in production set-up

J. Follower rest--used to support long work that is usually held at both ends; mounted to the carriage, it prevents work from pushing away from tool

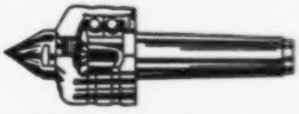
K. Four-jaw independent chuck--used to hold round or irregularly shaped parts; each jaw moves independently

L. High-speed threading attachment--used when cutting threads; allows speeds 2-3 times faster than are normally possible

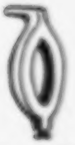
M. Knurling tool--special tool used to produce a diamond or straight pattern on work; is held in toolholder and moves with carriage



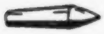
Adjustable Thread-Cutting Stop Travel



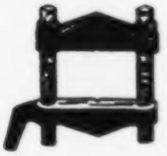
Ball-Bearing Center



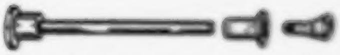
Bent-Tail Lathe Dog



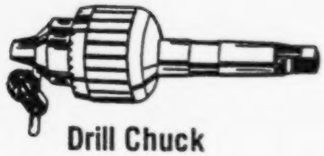
Center



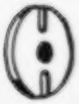
Clamping Lathe-Dog



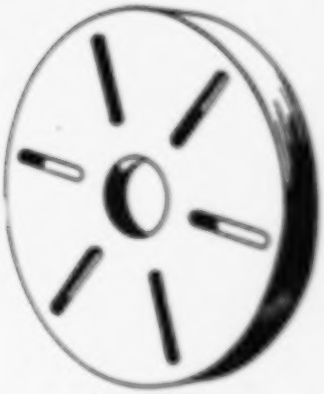
Collet Chuck with Drawbar and Adapter



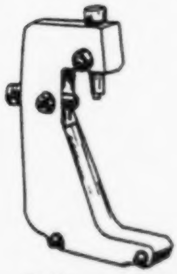
Drill Chuck



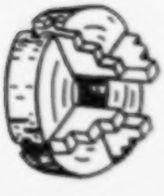
Drive Plate
(Dog Plate)



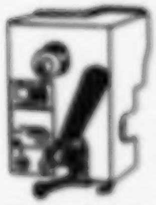
Face Plate



Follower Rest



Four-Jaw Independent Chuck



High-Speed Threading Attachment

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 169-173.

N. Lathe centers--used in headstock and tailstock when turning between centers; used in tailstock to support long work that must be machined

NOTE: The center in the headstock is called a live center because it revolves with the work and may or may not be hardened. The center in the tailstock is called a dead center because it does not revolve with the work. The dead center requires lubrication (synthetic white lead); it must also be hardened and occasionally has a carbide tip.

O. Mandrel--shaft or spindle on which work is fixed for rotation; slightly tapered; outside diameter can be machined true to inside diameter

P. Micrometer carriage stop--used to accurately control movement of carriage along length of bed

Q. Pipe center--used to support inside diameter of large pipe when turning; is mounted in tailstock and revolves with work

R. Quick-change tool post--used to mount toolholders; allows different tools to be used without adjustment each time

S. Sleeve adapter--used to adapt tapered-shank tools to taper of tailstock

T. Soft jaws--used on chucks with two-piece jaws; mounted in place of hard jaws so that jaws can be machined to conform to a particular radius; make holding pressure more uniform without cutting into work

U. Spindle adapter--adapts lathe-spindle taper to Morse taper, which holds center when work is to be turned between center; also holds drilling and reaming tools when work is mounted to carriage

V. Splash and chip guard--used to keep coolant from being thrown from revolving chuck or work; helps stop chips from flying as they break off

W. Steady rest--used to support long work; bolted to lathe bed

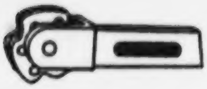
X. Taper attachment--used to cut internal or external tapers and tapered threads without moving alignment of tailstock; moves carriage crossfeed along desired taper when clamped to bed; graduated in degrees and inches per foot and mounted to carriage

Y. Three-jaw universal chuck--used to hold round parts where concentricity is not critical. Jaws can be changed or reversed for inside or outside holding, and all jaws move in unison.

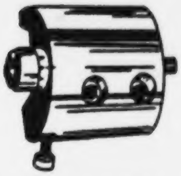
Z. Tool post--used to hold tool or toolholder; must be adjusted each time a different tool or toolholder is used

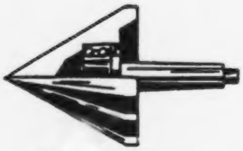
AA. Tool-post grinder--used to grind inside or outside diameters; mounted on carriage which controls its movements

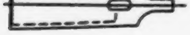
BB. Tracer attachment--used to cut tapers and other contours from a pattern

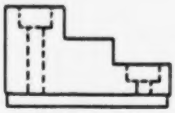

Knurling Tool

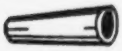
Mandrel

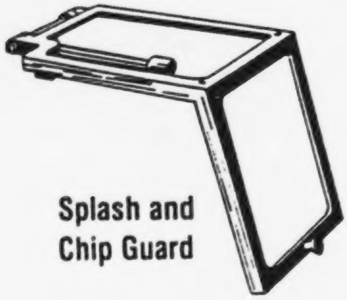

Micrometer
Carriage Stop

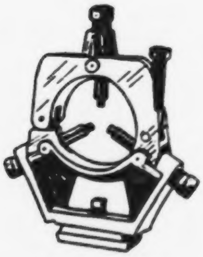

Pipe Center

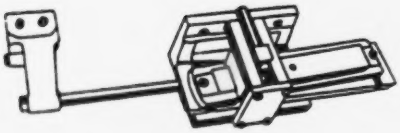

Sleeve Adapter

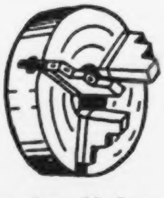

Soft-Jaws
for Chuck

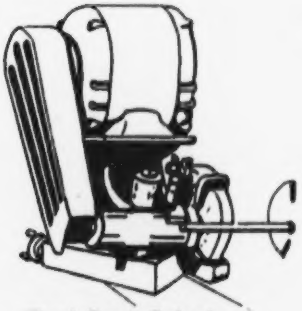

Spindle
Adapter

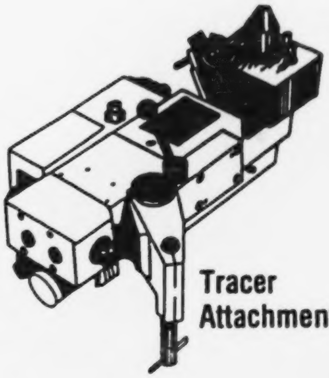

Splash and
Chip Guard


Steady Rest


Taper Attachment

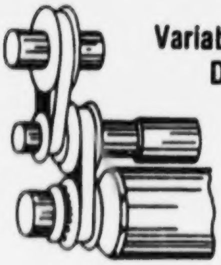

Three-Jaw Universal
Chuck


Tool-Post Grinder

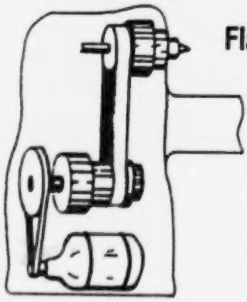

Tracer
Attachment

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 169-175.

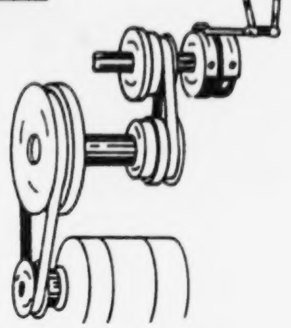
II. Types of spindle drives



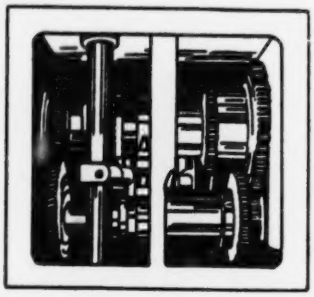
Variable Pulley Drive



Flat Belt Drive



Manual Shift V-Belt Drive



Geared-Head Drive

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 177.

III. Rules for care and cleaning of the engine lathe

A. Shut off electrical power before thoroughly cleaning machine.

B. Use compressed air with extreme caution. Do not force chips or dirt underneath felt wipers or between bearing surfaces--flying chips can cause injury.

C. When cleaning, use a brush to remove chips. Wipe with clean cloth to remove dirt and sludge, and then wipe a thin coat of protective oil on all finished steel surfaces to prevent rust.

D. Oil levels should be checked daily.

E. For lubrication, check charts in owner's manual to determine frequency and type of lubricant.

F. Gibs should never be adjusted before checking with instructor.

G. Check with instructor before replacing shear pins.

CAUTION: Never use nails or wire as shear pins. Shear pins are designed to withstand a certain amount of torque, and improper pins can cause serious damage.

H. Report to instructor if machine pulls down or is slow to reach speed, as these actions will damage the clutch.

IV. Rules for safe use of the engine lathe

A. Wear approved safety glasses with side shields.

B. Watches and rings should be removed before operating machinery.

C. Wear close-fitting clothes with shirttail tucked into pants; button or roll up long sleeves past the elbow.

D. Horseplay is strictly prohibited in shop area.

E. When measuring, adjusting, cleaning or oiling, stop the lathe.

F. Never use hands to try to stop lathe spindle or chuck, to grab chips or to remove hot work from work-holding device.

G. Never use rags around revolving or moving parts.

H. Never operate a machine with guards removed.

I. Remove chuck wrenches immediately; never leave them in chuck.

J. Keep floor clean and free of chips and oil to eliminate slipping hazards.

K. Always check work-holding devices for secure mountings.

L. Never leave tools lying on machine.

M. Always clean chucks before mounting on spindle; never set directly on the ways. (Use a wooden chuck cradle.)

N. For large or oddly shaped parts that are chucked, rotate work a complete revolution by hand to make sure jaws and work clear the ways and carriage.

O. Remove all sharp edges and burrs from work.

JS 1.1

CLEAN AND LUBRICATE ENGINE LATHE AND EQUIPMENT

Equipment:

Engine lathe
Manufacturer's specifications
Proper solvent cleaner
Clean, absorbent cloth
Brush
Recommended lubricant
Eye protection
Broom and dust pan
Hand tools
Wrenches

INSTRUCTOR'S NOTE: For the purpose of this evaluation, a lathe should be provided with the chuck and workpiece removed.

Procedure:	Evaluation 3	 2	 1	 N
1. Obtain manufacturer's specifications for lathe.	___	___	___	___
2. Turn off power. Remove all accessories from lathe.	___	___	___	___
3. Remove chips and abrasive particles with brush or cloth.	___	___	___	___
4. Clean machine with proper solvent-soaked cloth. Wipe down all hoses and lathe accessories with proper solvent-soaked cloth.	___	___	___	___
5. Lubricate lathe according to manufacturer's specifications.	___	___	___	___
6. Inspect lathe. Ask instructor to inspect your machine.	___	___	___	___
7. Sweep area clean and carefully discard refuse.	___	___	___	___
8. Return all tools, accessories and equipment to proper location.	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's final evaluation for competency I2: Perform care and maintenance.

MODULE: LATHES

UNIT II: ACCESSORIES, MAINTENANCE AND SAFETY

UNIT TEST

Match the following definitions or uses with appropriate terms or tools.

____ 1. Cuts tapers and other contours from a pattern

____ 2. Mounts toolholders; allows different tools to be used without adjustment each time

____ 3. Transmits power from spindle to work by means of lathe dog; mounted directly to spindle

____ 4. Holds round parts where concentricity is not critical; jaws can be changed for inside or outside holding; all jaws move in unison

____ 5. Holds work from the inside of a round hole by means of a slight taper and is then mounted between centers; outside diameter can be machined true to inside diameter

____ 6. Special tool used to produce a diamond or straight pattern on work; is held in toolholder and moves with carriage

____ 7. Supports inside diameter of large pipe when turning; is mounted in tailstock and revolves with work

____ 8. Cuts internal or external tapers and tapered threads without moving alignment of tailstock; moves carriage crossfeed along desired taper when clamped to bed; graduated in degrees and inches per foot and mounted to carriage

____ 9. Allows four tools to be preset; tools can be rotated by loosening lock; excellent for short production runs

____ 10. Adapts tapered-shank tools to tailstock taper

____ 11. Clamps to round work and transmits power from drive plate to work

____ 12. Used in headstock and tailstock when turning between centers; used in tailstock to support long work that must be machined

____ 13. Accurately controls movement of carriage along length of bed

a. Compound-turret tool holder

b. Sleeve adapter

c. Micrometer carriage stop

d. Bent-tail lathe dog

e. Taper attachment

ab. Three-jaw universal chuck

ac. Drive plate (dog plate)

ad. Pipe center

ae. Mandrel

bc. Tracer attachment

bd. Knurling tool

be. Quick-change tool post

cd. Lathe centers

Choose the option which answers the question or completes the statement.

____ 14. What must be worn in the shop area?

a. Safety helmet
b. Comfortable, loose-fitting clothing
c. Safety glasses with side shields
d. All of the above
e. None of the above

____ 15. Which is an improper safety guideline for shop attire?

a. Watches and rings must be removed before operating machinery.
b. Wear close-fitting clothes with shirttails tucked into pants.
c. Roll up long sleeves past the elbow.
d. Shirts with sleeves that button should be avoided.
e. All of the above

____ 16. What safety rule should always be followed?

a. Horseplay is strongly discouraged in the shop area.
b. Only clean rags should be used around revolving parts.
c. Never leave tools lying on machine.
d. Sharp edges and burrs are usually removed from work.
e. The lathe should be unplugged before measuring, adjusting, cleaning or oiling.

____ 17. Which statement is false?

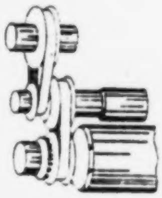
a. Never use hands to stop lathe spindle or chuck, to grab chips or to remove hot work from work-holding device.
b. Never operate a machine with guards removed.
c. The chuck wrench must be removed immediately; it should never be left in the chuck.
d. The floor should be kept clean and free of chips and oil to eliminate slipping and tripping hazards
e. Always check work-holding devices to make sure that they are free of chips and debris.

____ 18. Which is a sound equipment-handling guideline?

a. Large or oddly shaped parts that are chucked should be hand-rotated one revolution to make sure jaws and work clear ways and carriage.
b. Always clean chuck before mounting on spindle
c. Never set a chuck directly on the ways.
d. Large or oddly shaped parts that are chucked should be slowly rotated several revolutions to make sure jaws and work clear ways and carriage.
e. All of the above

____ 19. Identify the type of spindle drive pictured below.

a. Flat belt
b. Geared-head
c. Variable pulley
d. Manual shift V-belt
e. Round belt



ANSWERS TO UNIT TEST

1. bc
2. be
3. ac
4. ab
5. ae
6. bd
7. ad
8. e
9. a
10. b
11. d
12. cd
13. c
14. c (I1)
15. d (I1)
16. c (I1)
17. e (I1)
18. a (I1)
19. c

MODULE: LATHES

UNIT III: LATHE OPERATIONS AND TOOLING

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify types of lathe operations and tooling and off-hand grinding lathe tools. This knowledge will be evidenced through demonstration and by achieving a specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match basic lathe operations to definitions or illustrations.

1.2 Identify types of tool posts and tool holders.

1.3 Determine uses for types of tool posts and tool holders.

2.1 Identify basic shapes of single-point cutting tools.

2.2 Match types of carbide to applications.

2.3 Compare advantages and disadvantages of carbide and high-speed steel cutting tools.

2.4 Free-hand grind turning tool. (competency I6, JS 2.1)

2.5 Free-hand grind facing tool. (competency I6, JS 2.2)

2.6 Free-hand grind 60° threading tool. (competency I19, JS 2.3)

2.7 Operate lathe controls. (competency I8, JS 2.4)

MODULE: LATHES

UNIT III: LATHE OPERATIONS AND TOOLING

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: LATHE OPERATIONS
    a. Information outline
2. Lesson 2: HIGH SPEED AND CARBIDE LATHE TOOL BITS
    a. Information outline
    b. Assignment sheet
        AS 2.1: Carbide cutting tools
    c. Job sheets
        JS 2.1: Free-hand grind turning tool
        JS 2.2: Free-hand grind facing tool
        JS 2.3: Free-hand grind 60° threading tool
        JS 2.4: Operate lathe controls

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.
2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.
3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.
4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

   a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

   b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

   c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.

   d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

   e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

2. Audiovisual

   a. Performing Facing and Turning Operations (MS-84-352) (video). Sedalia, MO: State Fair Community College, 1984. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610).

MODULE: LATHES

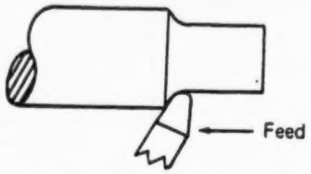
UNIT III: LATHE OPERATIONS AND TOOLING

LESSON 1: LATHE OPERATIONS

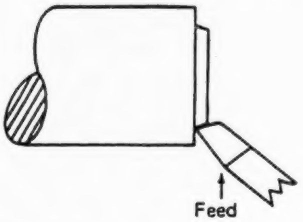
I. Basic lathe operations

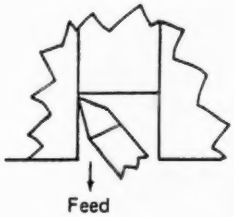
NOTE: This lesson's artwork is used with permission from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 123-132, fig. 1-17.

A. Turning--removing material from outside surface of part

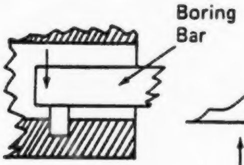


B. Facing--removing material from end surface of part

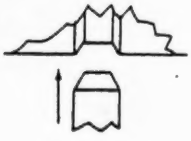




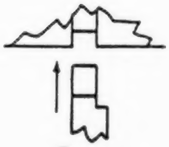
C. Grooving--cutting a recess in work



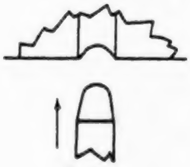
Thread
Relief



V-Groove

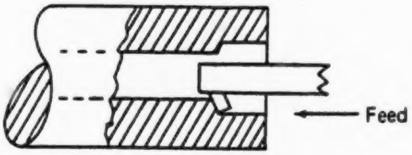


Square
Groove



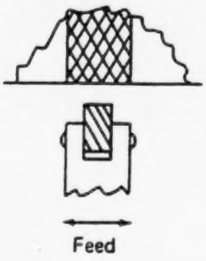
Round
Groove

D. Boring--enlarging an existing hole

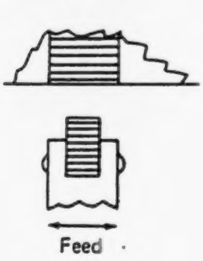


E. **Knurling--producing a raised pattern on surface of work to improve grip or appearance or to increase diameter**

Diamond Knurl

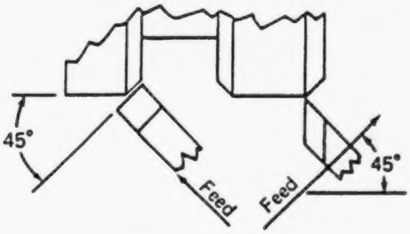


Straight Knurl

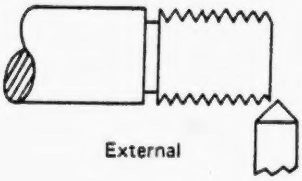


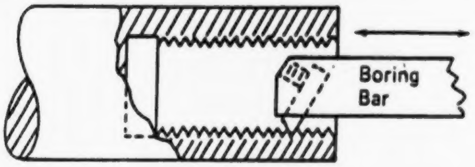
F. Chamfering--producing a flat, angular surface on the edge of a machined part

NOTE: Chamfer may be cut or formed, depending on its size.



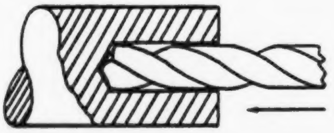
G. Threading--forming internal or external threads with a single-point tool


External

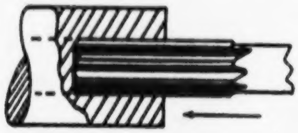


Internal

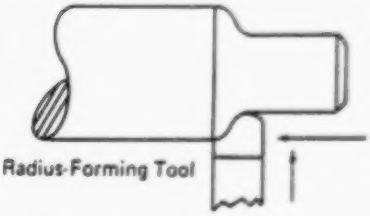
H. Drilling--producing a hole with a drill



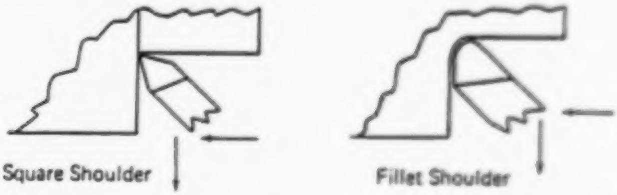
I. Reaming--enlarging a hole slightly with a multi-fluted cutter



J. Forming--producing a desired shape by using a tool ground to that shape

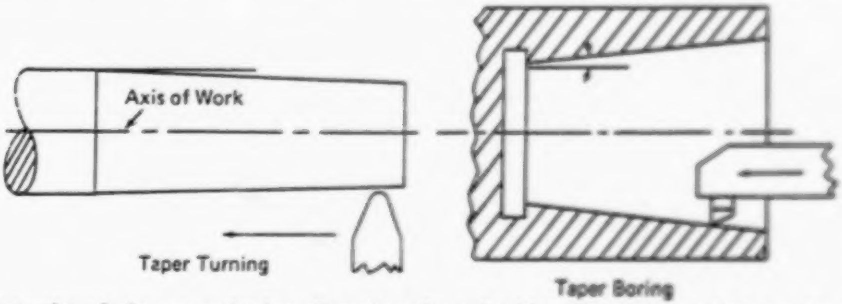


K. Shouldering--finishing surface where two diameters or steps meet


Square Shoulder

Fillet Shoulder

L. Tapering--increase or decrease of workpiece size along its axis at a uniform rate



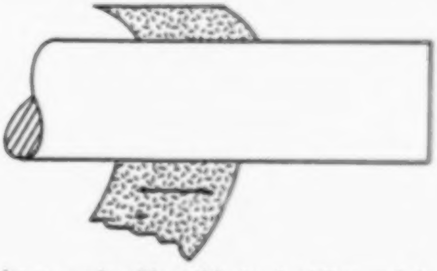
Taper Turning

Taper Boring

M. Filing--chamfering or reducing diameter of work with a file while work is rotating

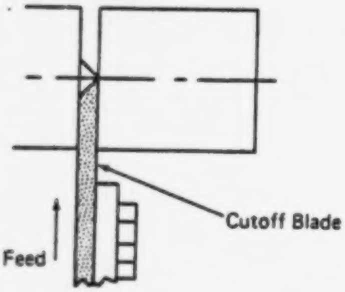
CAUTION: Hold file handle with the left hand when filing near chuck.

N. Polishing--improving surface finish of part with abrasive cloth while work is turning



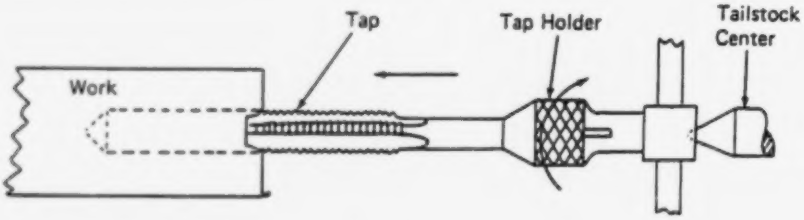
O. Cutoff--cutting a part from work with a thin tool while work is rotating

CAUTION: Cut-off operations should never be done on work that is held between centers or supported with a center.

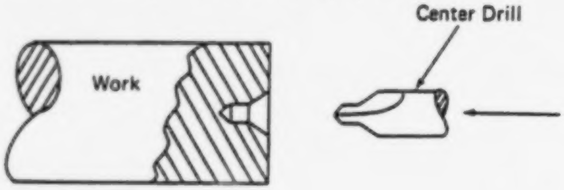

Cutoff Blade
Feed

P. Tapping--producing internals threads with a tap, using the lathe tailstock to guide tap

NOTE: Power is off when machinist performs this operation, and lathe is set in low range to prevent spindle from turning.


Tap
Tap Holder
Tailstock Center
Work

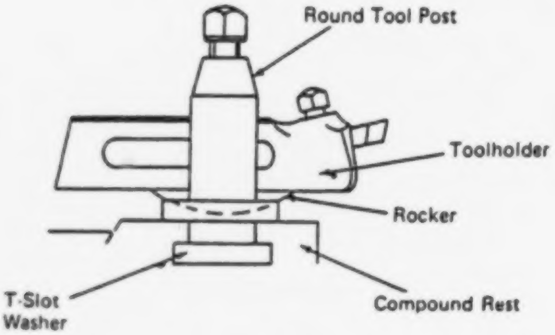
Q. Center drilling--producing a tapered hole in end of work so that part can be held between centers or be used as starting hole for drilling operation


Center Drill
Work

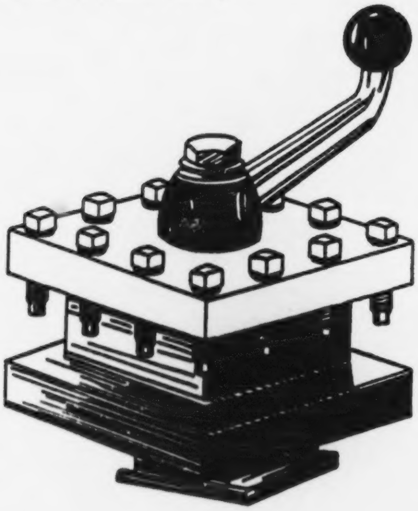
II. Types of tool posts and toolholders

A. Round tool post and toolholder

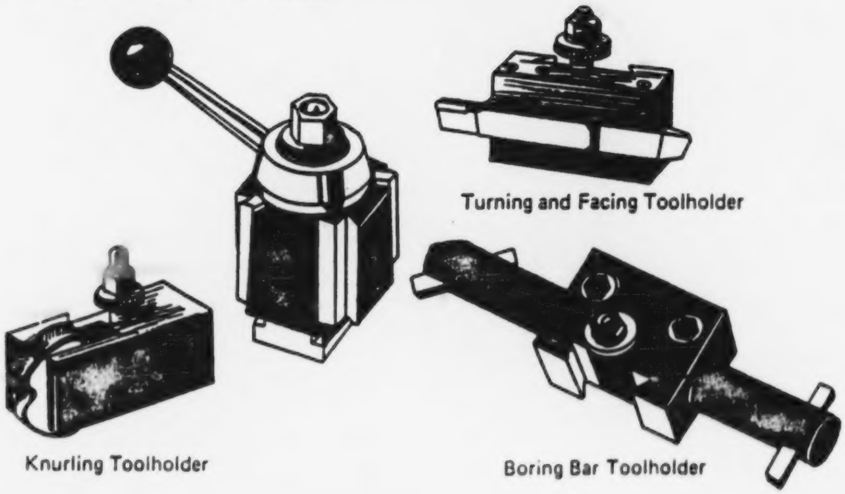
NOTE: Tool posts and holders come in a number of designs. Some designs are combination posts and holders.


Round Tool Post
Toolholder
Rocker
T-Slot Washer
Compound Rest

B. Compound-turret tool post (square turret)



C. Quick-change tool post and holders

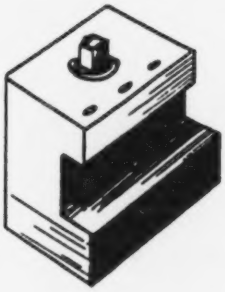


Turning and Facing Toolholder

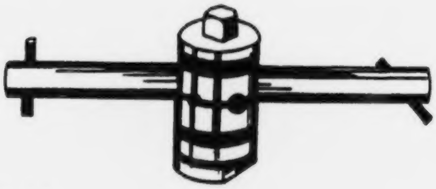
Knurling Toolholder

Boring Bar Toolholder

D. Heavy-duty, open-face tool post and holder



E. Boring bar and holder



III. Uses of tool posts and toolholders

A. Round tool post and holders--used to get into tight places when work is supported with tailstock

B. Heavy-duty, open-face post--holds high-speed or carbide cutting tools for heavy machining

C. Quick-change toolholder--allows tools to be preadjusted and changed without readjusting; can be used for short-run production; holds high-speed or carbide cutting tools for medium machining

D. Turret tool post and holder--holds high-speed or carbide tools for heavy machining; holds four tools; indexes and repeats itself for production machining

E. Boring bar holder--holds boring bar for internal turning or boring

MODULE: LATHES

UNIT III: LATHE OPERATIONS AND TOOLING

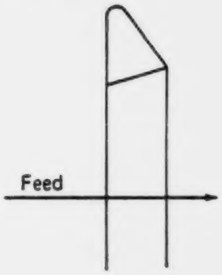
LESSON 2: HIGH SPEED AND CARBIDE LATHE TOOL BITS

I. Basic shapes of single-point cutting tools

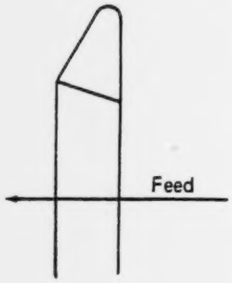
NOTE: Tool bit geometry--shape produced by grinding of proper angles on a cutting tool, allowing maximum chip removal and tool life, and producing the desired finish.

NOTE: This lesson's artwork is used with permission from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 133-139, fig. 23-50.

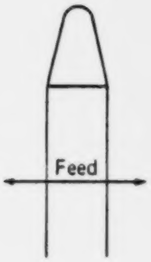
A. High-speed steel



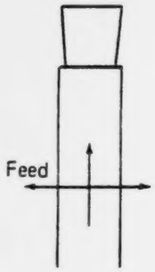
1. Left-hand turning



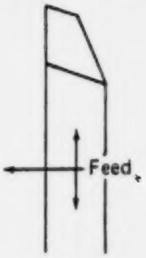
2. Right-hand turning



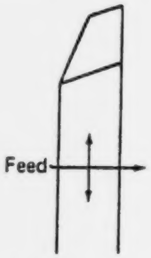
3. Round-nose turning



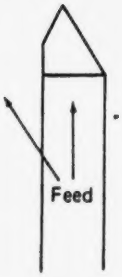
4. Square-nose chamfer or turning



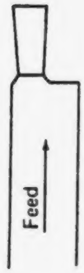
5. Right-hand facing



6. Left-hand facing

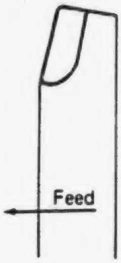


7. Threading

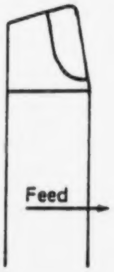


8. Parting or grooving

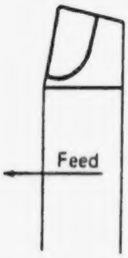
B. Brazed carbide



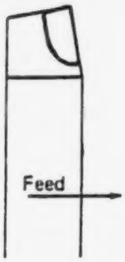
1. Right-hand rough turning



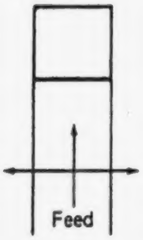
2. Left-hand rough turning



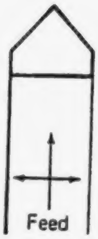
3. Right-hand finish turning



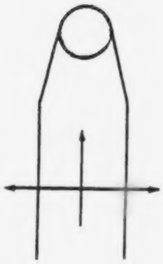
4. Left-hand finish turning



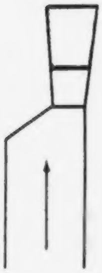
5. Square-nose chamfer or turning



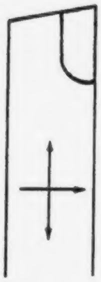
6. V-grooving or turning



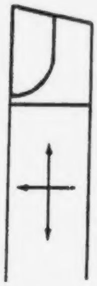
7. Round-nose grooving or turning



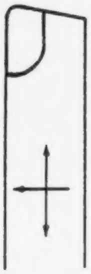
8. Parting or recessing



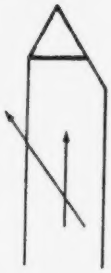
9. Left-hand facing or shouldering



10. Right-hand facing or shouldering

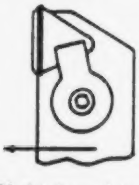


11. Right-hand rough turning or facing

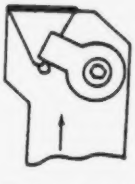


12. Right-hand threading

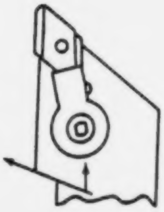
C. Carbide inserts



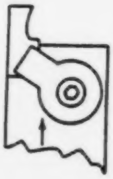
1. Right-hand turning



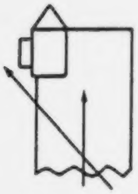
2. Right-hand facing



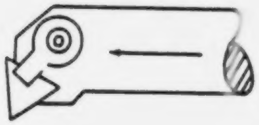
3. Right-hand tapering or contouring



4. Right-hand grooving



5. Right-hand threading



6. Boring

II. Applications of types of carbide

NOTE: There are many grades of carbide for a variety of materials and operations. Different companies may specify a different brand and grade number.

A. Cemented oxide (uncoated)--very high-speed finishing on all types of materials; basically used for light chip loads on very rigid setups

B. Complex tungsten carbide (TiC coated)--medium roughing to finishing on a broad variety of plain carbon steels, alloy steels, free-machining steels, tool steels, and 400- and 500-series stainless steels; very good general-purpose, coated grade

C. Complex tungsten carbide (uncoated)--medium to very heavy roughing on a broad variety of plain carbon steels, alloy steels, tool steels, free-machining steels, 400- and 500-series stainless steels, and alloy cast irons; very good general-purpose, uncoated grade that is good for turning and milling

D. Complex tungsten carbide (Al_2O_3 coated)--finishing to high-speed finishing on a broad variety of cast irons and steels

E. Straight tungsten carbide (TiC coated)--light roughing to finishing on a broad variety of cast irons and steels

F. Straight tungsten carbide (uncoated)--medium roughing to finishing on nodular, malleable, gray or chilled cast iron; 200- and 300-series stainless steels; a broad variety of high-temperature, high-strength alloys; and refractory alloys and nonmetals

III. Advantages and disadvantages of carbide and high-speed steel

A. Carbide

1. Advantages

a. Allows use of higher cutting speeds and feeds

b. Has longer tool life

c. Allows greater production output

d. Inserts are pre-ground

e. Machines harder materials

2. Disadvantages

   a. Older machines are not rigid and lack required speeds.

   b. Induces internal stress in work with high carbon content

   c. Easily broken or chipped

B. High-speed steel

   1. Advantages

      a. Can be ground easily to different shapes

      b. Excellent for some nonferrous and nonmetal materials that require extreme clearance and relief angles

   2. Disadvantages

      a. Must be ground to shape

      b. Will not withstand high temperatures

      c. Must be sharpened often

      d. Will not cut some very hard metals

AS 2.1

CARBIDE CUTTING TOOLS

Idehtify carbide inserts by matching terms and illustrations.

____ 1. Boring

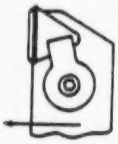
____ 2. Right-hand grooving

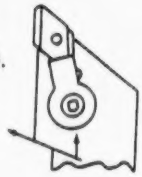
____ 3. Right-hand tapering or contouring

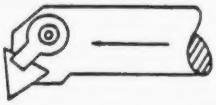
____ 4. Right-hand turning

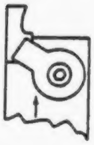
____ 5. Right-hand threading

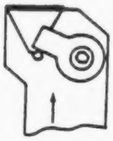
____ 6. Right-hand facing

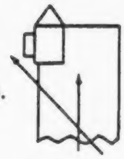
a.


b.


c.


d.


e.


ab.


Match basic shapes of brazed carbide cutting tools with terms.

____ 7. Right-hand threading facing

____ 8. Right-hand finish turning

____ 9. Left-hand finish turning

____ 10. Right-hand rough turning

____ 11. V-grooving or turning

____ 12. Left-hand facing or shouldering

____ 13. Right-hand rough turning or facing

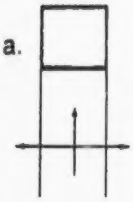
____ 14. Parting or recessing

____ 15. Left-hand rough turning

____ 16. Square-nose chamfer or turning

____ 17. Round-nose grooving or turning

____ 18. Right-hand facing or shouldering

a.


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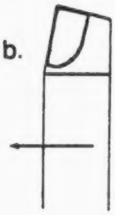

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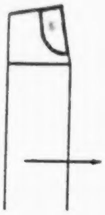

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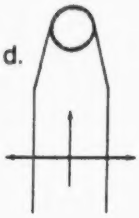

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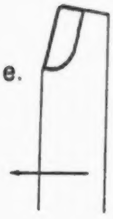

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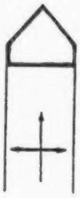
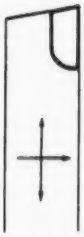
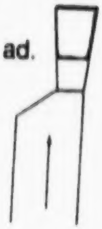


62

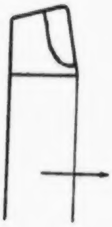
ac.



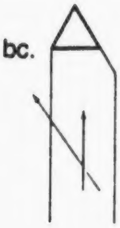
ad.



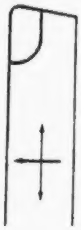
ae.



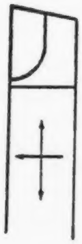
bc.



bd.



be.



ANSWERS TO AS 2.1

1. c
2. d
3. b
4. a
5. ab
6. e
7. bc
8. b
9. c
10. e
11. ab
12. ac
13. bd
14. ad
15. ae
16. a
17. d
18. be

FREE-HAND GRIND TURNING TOOL

Equipment:

Steel key stock, 3/8" square, 3" long
High-speed tool blank, 3/8" square
Pedestal grinder
Goggles
Grinding wheel dresser
Oilstone

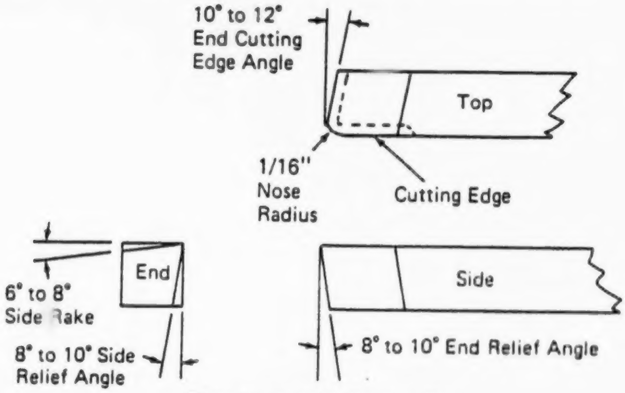
Procedure:	Evaluation 3	2	1	N
1. Prepare for grinding.	—	—	—	—

CAUTION: Use goggles at all times to protect eyes from grinding dust.

a. Dress both coarse and fine-grit aluminum oxide grinding wheels if required.

b. Adjust tool rest and spark breakers if necessary.

CAUTION: Never make adjustments until grinding wheel has stopped.



10° to 12° End Cutting Edge Angle
Top
1/16" Nose Radius
Cutting Edge
End
6° to 8° Side Rake
8° to 10° Side Relief Angle
Side
8° to 10° End Relief Angle

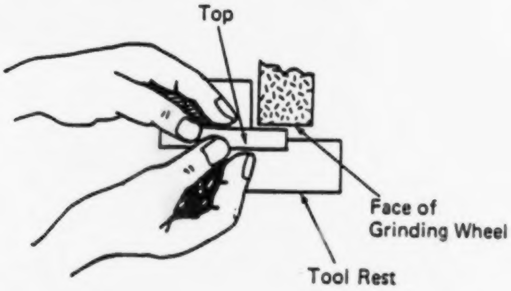
Right-Hand (RH) Turning Tool

NOTE: This job sheet's artwork is used with permission from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 193-197, fig. 52-58.

2. Grind cutting edge and side relief angle.

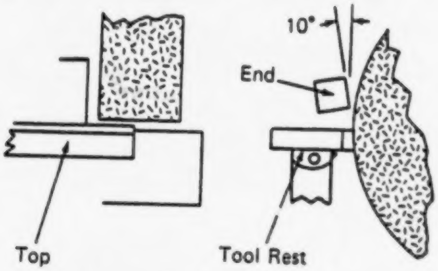
NOTE: Use key stock first to practice the procedure.

a. Hold tool with fingers and thumbs of both hands and place tool so that left side is parallel to face of coarse grinding wheel. – – – –


Top
Face of Grinding Wheel
Tool Rest

b. Tilt top of tool away from wheel about 10°; bring tool into contact with wheel and grind side relief angle and cutting edge at same time.

NOTE: Make cutting edge about the width of the tool.

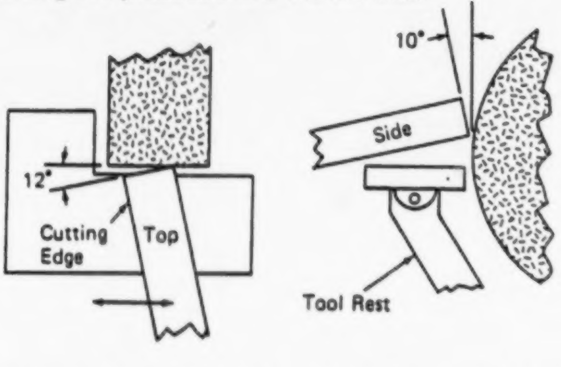

10°
End
Top
Tool Rest

c. Continue to grind until side relief angle blends with cutting edge at top of tool.

NOTE: Do not allow the tool to overheat.

3. Grind end cutting edge and end relief angles. – – – –

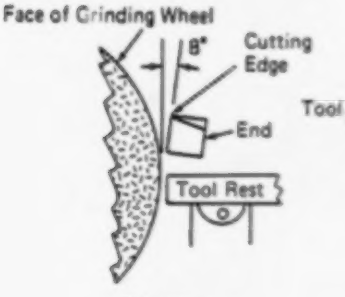
a. Position tool so that end of tool is about 12° to face of wheel with cutting edge side away from wheel; tilt end of tool up about 10° so that an end relief angle is produced at the same time.


12°
Cutting Edge
Top
10°
Side
Tool Rest

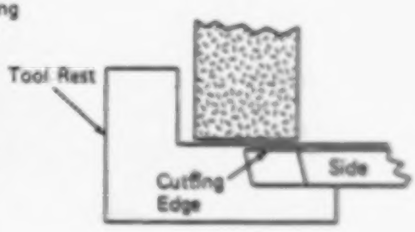
b. Bring tool into contact with wheel; grind end relief angle until it has reached top of tool, forming the end cutting edge angle.

4. Grind side and back rake angles. — — — —

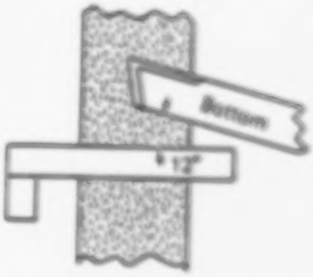
a. Hold top of tool parallel to face of wheel so that cutting edge is up. Tilt point of tool up about 12° and tilt cutting edge about 8° away from grinding wheel.


Face of Grinding Wheel
8°
Cutting Edge
End
Tool Rest

Side View


Tool Rest
Cutting Edge
Side

Top View



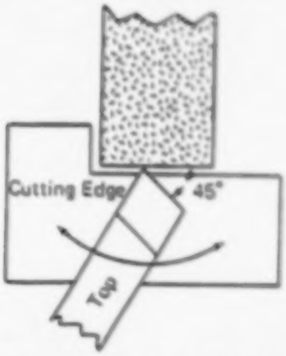
Front View

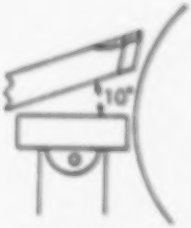
b. Bring tool into contact with grinding wheel; grind side rake angle until it reaches cutting edge.

NOTE: This tool has a neutral back rake angle. For a positive or negative angle, tilt the point either toward or away from the grinding wheel.

5. Grind nose radius. — — — —

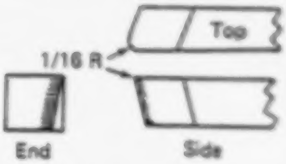
a. Hold end of tool at about a 45° angle to face of wheel with cutting edge toward wheel; tilt point up about 10°.


Cutting Edge
45°
Top



b. Bring tool in to wheel and rotate point between side cutting edge and end cutting edge until you have ground the 1/16" radius.

NOTE: The nose radius must follow the nose clearance to maintain the clearance angle.


Top
1/16 R
End
Side

6. Repeat steps 1-5 using the fine-grit wheel to produce finished surface. — — — —

7. Hone cutting edges of tool bit slightly with an oilstone to remove wire edges. Hold tool and work stone across cutting edges. ___ ___ ___ ___

8. When confident with the procedure, grind the tool using the high-speed steel blank. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency I6: Free-hand grind turning and facing tools.

JS 2.2

FREE-HAND GRIND FACING TOOL

Equipment:

Steel key stock, 3/8" square, 3" long
High-speed steel tool blank, 3/8" square
Pedestal grinder
Goggles
Grinding wheel dresser
Oilstone

Procedure:	Evaluation 3	2	1	N
1. Prepare for grinding.	—	—	—	—
CAUTION: Use goggles at all times to protect eyes from grinding dust. Never make adjustments until grinding wheel has stopped.				
2. Grind cutting edge and side relief angle.	—	—	—	—
3. Grind end cutting edge and end relief angles.	—	—	—	—
4. Grind side and back rake angles.	—	—	—	—
5. Repeat steps 1-4 with the fine-grit wheel to produce finished surfaces.	—	—	—	—
6. Hone cutting edges of tool bit slightly with an oilstone to remove wire edges; hold tool and work stone across cutting edges.	—	—	—	—
7. When confident with the procedure, grind the tool using the high-speed steel bank.	—	—	—	—
Average of above evaluations*	—	—	—	—

*This average completes the student's evaluation for competency I6: Free-hand grind turning and facing tools.

JS 2.3

FREE-HAND GRIND 60° THREADING TOOL

Equipment:

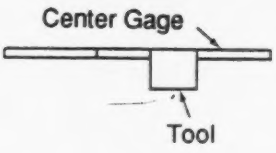
Steel key stock, 3/8" square, 3" long
High-speed steel tool blank, 3/8" square
Pedestal grinder
Goggles
Grinding wheel dresser
Center gage
Oilstone

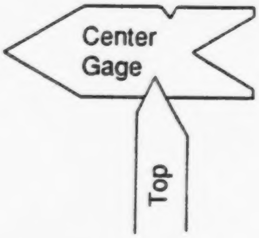
Procedure:	Evaluation 3	2	1	N
1. Prepare for grinding.	___	___	___	___

CAUTION: Use goggles at all times to protect eyes from grinding dust. Never make adjustments until grinding wheel has stopped.

	3	2	1	N
2. Grind left cutting edge and side relief angles.	___	___	___	___
3. Grind right cutting edge and side relief angles.	___	___	___	___
4. Check the 60° angle.	___	___	___	___

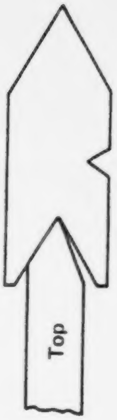
a. Insert tool point into deeper "V" on side of center gage; hold top of tool flush with center gage.



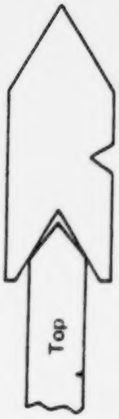


b. With tool in gage, hold it toward a light to see if tool fits accurately.

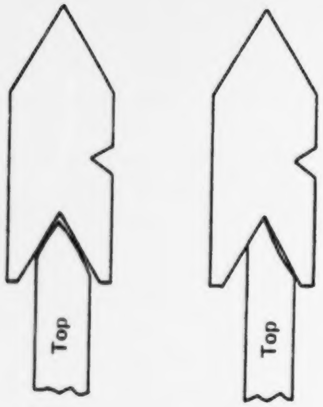
NOTE: This job sheet's artwork is used with permission from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 206-207, fig. 69-72.



Angle of Tool
Less than 60°

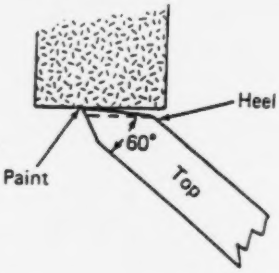


Angle of Tool
Greater than 60°



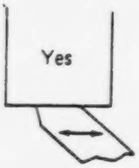
One or Both
Sides Not Straight

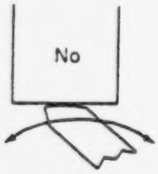
c. If angle is less than 60°, hold point to wheel and grind until blended into side.



d. If angle is greater than 60°, reduce angle by grinding at heel until blended into point.

e. If sides are not straight, redress grinding wheel and move tool across wheel in a straight line, not in an arc.





f. Continue grinding and checking with center gage until tool fits gage.

5. Repeat steps 1-4 with fine-grit wheel to produce finished surfaces. — — — —

6. Hone cutting edges of tool slightly with an oilstone to remove wire edges; hold tool and work stone across cutting edges. — — — —

7. When confident with the procedure, grind the tool using the high-speed steel blank. — — — —

Average of above evaluations* — — — —

*This average completes the student's evaluation for competency I19: Free-hand grind 60° threading tool.

JS 2.4

OPERATE LATHE CONTROLS

NOTE: The better an operator knows the location of lathe controls, what they do and how they work, the easier it will be to learn skills necessary to perform various engine lathe operations.

Equipment--Engine lathe

Procedure:	Evaluation 3	 2	 1	 N

NOTE: The procedures explained below are those for a Colchester 15" engine lathe. If another type of equipment is in your shop, use the operator's manual to perform the tasks listed below.

	3	2	1	N
1. Check the spindle-clutch lever, feed-clutch lever and half-nut lever to make sure they are in a neutral or disengaged position.	—	—	—	—
2. Make sure carriage lock screw is loose.	—	—	—	—
3. Depress one-shot oiler or lubricate carriage. Check all oil sight gages for proper levels. NOTE: If low, notify instructor so proper oil can be added.	—	—	—	—
4. Set spindle speed at about 500 rpm. Set feed rate of carriage at 0.008" per revolution (ipr).	—	—	—	—
5. Use hand feed controls. a. Move carriage right and left. b. Turn cross-feel handwheel to move cross slide in and out. c. Turn compound handwheel and move compound slide back and forth. d. Loosen locking screws on protractor base and set compound 30° to right of cross-feed; snug locking screws. NOTE: Instructor must be present before next step!	—	—	—	—
6. Turn main motor on. a. Start spindle. b. Set feed change controls so that carriage will move to right; then engage feed clutch lever and allow carriage to move right 6-7". c. Change feed direction with feed reverse controls; engage feed clutch lever and allow carriage to move left 5-6". d. Set feed change shaft so cross-slide will move; engage feed clutch lever and move cross slide in and out by means of power.	—	—	—	—
7. Slide tailstock about 2" to right and tighten lock; turn tailstock handwheel until reading shows that spindle is out of housing 3"; tighten spindle lock.	—	—	—	—

NOTE: Never stop machine without putting all clutches and feed levers in disengaged positions.

8. Stop spindle rotation with spindle clutch lever; shut off main power switch. — — — —

9. Ask instructor to demonstrate use of half-nut lever and thread-chasing dial and lathe set-up to cut different pitch threads. Set lathe to cut 8 threads per inch; set rpm at 60 and practice engaging half-nut lever on unnumbered lines of thread-chasing dial. — — — —

NOTE: Half-nut lever is engaged on either numbered or unnumbered lines when cutting even numbers of threads.

10. Set lathe to cut 13 threads per inch; set rpm at 60 and practice engaging half-nut lever on numbered lines of thread-chasing dial. — — — —

NOTE: Odd numbers of threads are cut on numbered lines.

11. Practice setting rpm and feed rate at different settings and move carriage by means of power. — — — —

CAUTION: Do not use high rpm with fast feed rates. If you cannot remember how to stop the movement of the carriage, stop the machine by shutting off power or by stepping on emergency stop bar.

Average of above evaluations* — — — —

*This average is the student's final evaluation for competency I8: Operate lathe controls.

MODULE: LATHES

UNIT III: LATHE OPERATIONS AND TOOLING

UNIT TEST

Match basic lathe operations to descriptions.

____ 1. Forming internal or external threads with a single-point tool

____ 2. Producing a hole with a drill

____ 3. Producing internal threads with a tap using lathe tailstock to guide tap

____ 4. Finishing surface where two diameters or steps meet

____ 5. Producing a desired shape by using a tool ground to that shape

____ 6. Enlarging a hole slightly with a multi-fluted cutter

____ 7. Cutting a recess in work

____ 8. Enlarging an existing hole

____ 9. Producing a tapered hole in end of work so that part can be held between centers or be used as a starting hole for drilling operation

____ 10. Cutting a part from work with a thin tool while work is rotating

____ 11. Removing material from end surface of part

____ 12. Chamfering or reducing diameter of work with a file while work is rotating

____ 13. Producing a raised pattern on surface of work to improve grip or appearance or to increase diameter

____ 14. Producing a flat, angular surface on the edge of a machined part

____ 15. Removing material from outside surface of part

a. Threading
b. Drilling
c. Forming
d. Shouldering
e. Reaming
ab. Tapping
ac. Grooving
ad. Boring
ae. Center drilling
bc. Facing
bd. Cutoff
be. Filing
cd. Turning
ce. Knurling
de. Chamfering

Identify types of tool posts and toolholders.

____ 16. Round tool post and tool-holder

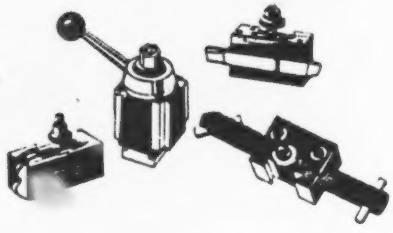
____ 17. Compound-turret tool post (square turret)

____ 18. Quick-change tool post and holders

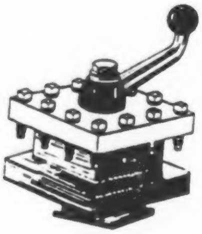
____ 19. Heavy-duty, open face tool post and holder

____ 20. Boring bar and holder

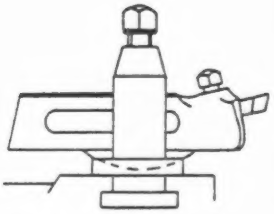
a.



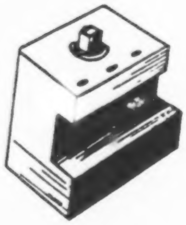
b.



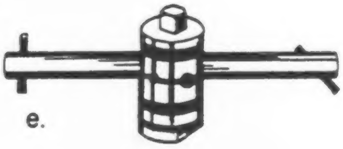
c.



d.



e.



Match terms with basic shapes of high-speed steel cutting tools and carbide inserts (shown on this and the next page).

____ 21. Square-nose chamfer or turning

____ 22. Left-hand turning

____ 23. Round-nose turning

____ 24. Internal threading

____ 25. Right-hand facing

____ 26. Threading

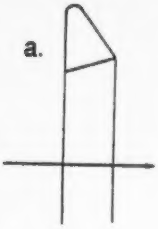
____ 27. Parting or grooving

____ 28. Right-hand turning

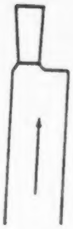
____ 29. Left-hand facing

____ 30. Boring

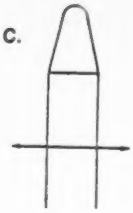
a.



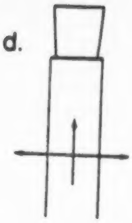
b.



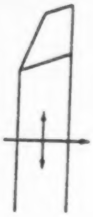
c.



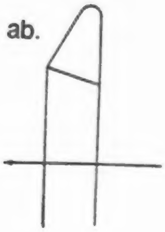
d.



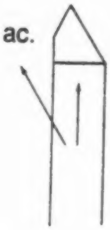
e.



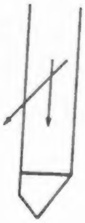
ab.



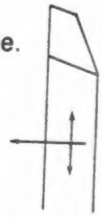
ac.



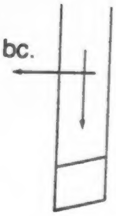
ad.



ae.



bc.



Match types of carbide to applications.

____ 31. Used for medium to very heavy roughing on a broad variety of steels and alloy cast irons; very good general-purpose, uncoated grade that is good for turning and milling

____ 32. Used for very high-speed finishing on all types of materials; basically used for light chip loads on very rigid setups

____ 33. Used for finishing to high-speed finishing on a broad variety of cast irons and steels

____ 34. Used for medium roughing to finishing on nodular, malleable, gray or chilled cast iron; 200- and 300- series stainless steels; a broad variety of high-temperature, high-strength alloys; and refractory alloys and nonmetals

____ 35. Used for medium roughing to finishing on a broad variety of plain carbon steels, alloy steels, free-machining steels, tool steels, and 400- and 500-series stainless steels; very good general-purpose, coated grade

____ 36. Used for light roughing to finishing on a broad variety of cast irons and steels

a. Cemented oxide (uncoated)

b. Straight tungsten carbide (TiC coated)

c. Straight tungsten carbide (uncoated)

d. Complex tungsten carbide (TiC coated)

e. Complex tungsten carbide (uncoated)

ab. Complex tungsten carbide (Al_2O_3 coated)

Select the option which answers the question or completes the statement.

____ 37. Carbide cutting tools have which of the following advantages?

a. Higher cutting speeds and feeds
b. Greater production output
c. Longer tool life
d. Machine harder materials
e. All of the above

____ 38. Which of the following is a disadvantage of carbide cutting tools?

a. Must be ground to shape
b. Will not withstand high temperatures
c. Easily broken or chipped
d. Will not cut some very hard materials
e. None of the above

____ 39. Which is an advantage of using high-speed steel cutting tools?

a. Higher cutting speeds and feeds
b. Greater production output
c. Longer tool life
d. Machine harder materials
e. Easy grinding to different shapes

____ 40. Which is a disadvantage of using high-speed steel cutting tools?

a. Must be ground to shape
b. Will not withstand high temperatures
c. Must be sharpened often
d. Will not cut some very hard materials
e. All of the above

____ 41. Which tool post/holder is used in tight places when work is supported by the tailstock?

a. Boring bar holder
b. Heavy-duty, open-face post
c. Quick-change toolholder
d. Round tool post and holder
e. Turret tool post and holder

ANSWERS TO UNIT TEST

1. a (I19)
2. b
3. ab
4. d
5. c
6. e
7. ac
8. ad
9. ae
10. bd
11. bc (I6)
12. be
13. ce
14. de
15. cd (I6)
16. c
17. b
18. a
19. d
20. e
21. d
22. a
23. c
24. ad
25. ae
26. ac
27. b
28. ab
29. e
30. bc
31. e
32. a
33. ab
34. c
35. d
36. b
37. e
38. c
39. e
40. e
41. d

MODULE: LATHES
UNIT IV: LATHE CALCULATIONS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to calculate speeds and feeds, depth of cuts and time required to turn or bore workpieces. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Calculate speeds and feeds for lathe set-up. (competency I5)

1.2 Determine cutting tool variables prior to use. (competency I4)

MODULE: LATHES

UNIT IV: LATHE CALCULATIONS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

    1. Lesson 1: LATHE CALCULATIONS

        a. Information outline

        b. Handout

            HO 1.1: Set-up charts

        c. Assignment sheets

            AS 1.1: Calculate feeds, speeds and time requirements for lathe set-up
            AS 1.2: Determine cutting tool variables prior to use

        d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.
2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.
3. Krar, S. F., J. W. Oswald and J. E. St. Amand. Technology of Machine Tools. 3rd ed. Toronto: McGraw-Hill, 1984.
4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.
2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Emphasize to students that time is money--when a shop bids on work, all time has been calculated so that the cost per part can be set. This requires that speeds, feeds and depth of cuts be determined correctly. (AS 1.2)

B. Suggested supplemental materials

1. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.
2. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.
3. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.
4. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.
5. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

MODULE: LATHES

UNIT IV: LATHE CALCULATIONS

LESSON 1: LATHE CALCULATIONS

I. Determining speed, feed and depths of cut using shop formulas and charts **(HO 1.1)**

NOTE: To do an effective job of lathe cutting, the work must turn at the proper speed and the tool must move at the correct feed.

A. Determine rpm. $\text{rpm} = \frac{4 \times \text{sfpm}}{D}$

NOTE: For drilling and boring, use the diameter of the drill or the bore. The 4 is constant.

1. Locate the type of material being machined on correct chart.

2. Use chart to determine roughing speed (over 0.150" depth of cut) and finishing speed (0.025" depth of cut) for type of cutting tool being used.

3. Put variables in formula and perform indicated math, rounding rpm to nearest whole number.

EXAMPLE: Operation--turning
Material--low-carbon steel 1020 annealed
Cutting speed (sfmp)
Roughing--high-speed steel 80
Finishing--high-speed steel 110
Diameter of work--3.0"

$$\text{Roughing rpm} = \frac{4 \times 80}{3} = \frac{320}{3} = 106.6 \text{ or } 107 \text{ rpm}$$

$$\text{Finishing rpm} = \frac{4 \times 110}{3} = \frac{440}{3} = 146.6 \text{ or } 147 \text{ rpm}$$

B. Determine feed rate

1. Locate the type of material to be used on correct chart.

2. Check feed rate for type of tool and required cut (rough or finish) for that material.

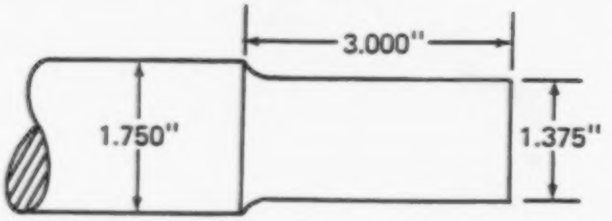
C. Determine depth of cut and number of cuts.

NOTE: Diameter of work, rigidity of machine, set-up, finish and total amount to be removed are factors in determining depth of cut. For maximum depths of cut in this unit, 0.150" is used for rough turning and 0.025" for finish turning operations. Depending on amount to be removed, the depth of rough and finish cuts may need to be reduced.

1. Subtract finish diameter from starting diameter.

EXAMPLE:

1.750"	Starting diameter
-1.375"	Finish diameter
0.375"	Total to be removed



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 141.

2. Subtract 0.050" from total to be removed. (Since the finish cut is 0.025" from each side, a total of 0.050" of material will be removed in the finish cut.)

EXAMPLE:

0.375"	Total to be removed
-0.050"	Material removed by .025" finish cut
0.325"	Total amount to be removed by rough cuts

3. To determine the number of rough cuts, subtract (or divide by) amount of material removed with each rough cut from total amount to be removed.

NOTE: The machine, tool and size of material are some of the factors that alter the depth of cut; make as few rough cuts as possible.

EXAMPLE: If 0.325" is to be removed by rough cutting, make two rough cuts.

0.325"	Total amount to be removed by rough cutting
-0.300"	Material removed by 0.150" rough cut
0.025"	Amount remaining to be removed by rough cutting
-0.025"	Material removed by second rough cut
0.000"	Amount remaining to be removed

4. Check diameter before making finish cut; adjust depth of cut for finish cut if necessary.

CAUTION: Care must be taken when turning work .500" or smaller as it will flex or bend under the pressure of cutting.

II. Factors to consider when calculating machining time

A. Speed (rpm)

B. Feed rate (ipr)

C. Length of cut

D. Number of cuts (amount of material to be removed)

$$\text{Time} = \frac{\text{Length of cut}}{\text{Speed x feed}}$$

EXAMPLE: Rough turn a 2" piece of 1020 steel bar to a diameter of 1.750" over a length of 3".

$$\text{rpm} = \frac{4 \times 120}{2} = 240$$

Feed rate = 0.015 ipr

$$T = \frac{3}{240 \times 0.015} = 0.83 \text{ minutes per rough cut}$$

Finish turn a 1.750" 1020 steel bar to a diameter of 1.718" over a length of 3".

$$\text{rpm} = \frac{4 \times 160}{1.75} = 366$$

Feed rate = 0.007 ipr

$$T = \frac{3.00}{366 \times 0.007} = 1.17 \text{ minutes}$$

Total time required for
rough and finish cuts = 0.83 Rough cut
+ 1.17 Finish cut
2.00 Total time

NOTE: If more than one cut is required for either type of operation, that time must also be added. For example, if two rough cuts were necessary for the above operation, the total time would have been 2.83 minutes (0.83 + 0.83 + 1.17).

SET-UP CHARTS

MATERIAL	Speed sfpm (CS)	CUTOFF AND FORMING FEED – INCHES PER REVOLUTION Cutoff Width-Inches 0.062	0.125	or 0.250	0.500	Forming Width-Inches 0.750	1.000	1.500	2.000	Tool Material*
Aluminum Alloys	500	0.003	0.003	0.004	0.004	00035	0.003	0.0025	0.002	H
--Wrought	825	0.002	0.006	0.008	0.005	0004	0.004	0.003	0.0025	C
Brass	340	0.003	0.004	0.005	0.003	0002	0.002	0.002	0.001	H
330-340-353	600	0.003	0.004	0.005	0.007	0006	0.005	0.004	0.003	C
Cast Iron	125	0.004	0.006	0.008	0.008	0006	0.006	0.005	0.004	H
Soft	345	0.008	0.012	0.015	0.016	0012	0.012	0.010	0.008	C
Cast Iron	50	0.002	0.003	0.003	0.003	00025	0.002	0.0015	0.0015	H
Hard	165	0.004	0.006	0.007	0.005	0005	0.004	0.0035	0.003	C
Carbon Steel (Lo)	110	0.0015	0.002	0.0025	0.0025	0002	0.0015	0.0015	0.001	H
1010-1020	360	0.0045	0.006	0.0075	0.005	0004	0.0035	0.0035	0.0025	C
Carbon Steel (Med)	65	0.001	0.0015	0.002	0.0015	00015	0.001	0.001	0.0007	H
1030-1055	230	0.003	0.0045	0.006	0.003	0003	0.0025	0.0025	0.0015	C
Carbon Steel (Hi)	55	0.001	0.0015	0.002	0.0015	00015	0.001	0.001	0.0007	H
1060-1095	190	0.003	0.0045	0.006	0.003	0003	0.0025	0.0025	0.0015	C
Alloy Steel (Med C)	65	0.0015	0.002	0.0025	0.0025	0002	0.0015	0.0015	0.001	H
4130-4140	225	0.0045	0.006	0.007	0.005	0004	0.0035	0.0035	0.0025	C
Tool Steel (HS)	55	0.001	0.001	0.0015	0.0015	0001	0.001	0.0007	0.0007	H
M-3, M-4, M-7	200	0.002	0.003	0.0045	0.003	00025	0.002	0.0015	0.0015	C
Stainless Steel	100	0.0015	0.002	0.002	0.0025	0002	0.002	0.0015	0.001	H
300 Series	325	0.004	0.005	0.006	0.006	0005	0.004	0.004	0.003	C
Stainless Steel	25	0.0015	0.002	0.0025	0.0025	0002	0.002	0.0015	0.001	H
400 Series	40	0.004	0.005	0.007	0.005	0004	0.004	0.0035	0.0035	C

*H=High-spend steel
C=Carbide

NOTE: Although these cutting speeds can be used to calculate lathe spindle speed, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, tpe of material being machined, and operator skill and experience.

MATERIAL	TURNING Finish*	Depth of Cut (Inches)	HIGH-SPEED STEEL TOL Speed sfpm (CS)	Feed ipr	CARBIDE TOOL Speed SFPM (CS) Brazed	Throw-away	Feed ipr
Aluminium Alloys	R	0.150	600	0.015	1100	1500	0.020
--Wrought	F	0.025	800	0.007	1400	1800	0.010
Brass	R	0.150	400	0.015	800	925	0.020
330-340-353	F	0.025	480	0.007	980	1100	0.007
Cast Iron	R	0.150	145	0.015	500	550	0.020
Soft	F	0.025	185	0.007	650	725	0.010
Cast Iron	R	0.150	80	0.015	300	340	0.015
Hard	F	0.025	120	0.007	360	410	0.007
Carbon Steel (Lo)	R	0.150	120	0.015	400	485	0.020
1010-1020	F	0.025	160	0.007	475	625	0.007
Carbon Steel (Med)	R	0.150	75	0.015	300	375	0.020
1030-1055	F	0.025	105	0.007	385	475	0.007
Carbon Steel (Hi)	R	0.150	85	0.015	275	345	0.015
1060-1095	F	0.025	85	0.007	360	440	0.007
Alloy Steel (Med C)	R	0.150	90	0.015	300	400	0.020
4130-4140	F	0.025	120	0.007	400	500	0.007
Tool Steel (HS)	R	0.150	60	0.015	250	290	0.015
M-3, M-4, M-7	F	0.025	65	0.007	275	320	0.007
Stainless Steel	R	0.150	105	0.015	425	475	0.015
300 Series	F	0.025	125	0.007	475	520	0.007
Stainless Steel	R	0.150	150	0.015	475	525	0.015
400 Series	F	0.025	170	0.007	525	580	0.007

*"R" designates rough cut depths to cut; "F" designates finish cut depths of cut.

NOTE: Although these cutting speeds can be used to calculate lathe spindle spee, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation,ze of material being machined, and operator skill and experience.

MATERIAL	Speed sfpm (CS)	DRILLING FEED – INCHES PER REVOLUTION NOMINAL HOLE DIAMETER – INCHES 1/16	1/8	1/4	1/2	3/4	1	1 1/2	2	Tool Material*
Aluminum Alloys	140	0.001	--	--	–	–	–	–	–	H
--Wrought	275	–	0.003	0.007	0.012	0.016	0.019	0.025	.030	H
Brass	140	0.001	–	--	–	–	–	–	–	H
330-340-353	200	--	0.003	0.006	0.010	0.013	0.016	0.021	0.025	H
Cast Iron	90	0.001	--	–	–	–	–	–	–	H
(Soft)	160	--	0.003	0.006	0.010	0.015	0.018	0.021	0.025	H
	350	--	0.003	0.006	0.010	0.014	0.017	0.021	0.025	C
Cast Iron	55	0.001	--	--	–	–	–	–	–	H
(Hard)	80	--	0.002	0.004	0.007	0.010	0.012	0.015	0.017	H
	180	--	0.002	0.004	0.007	0.010	0.012	0.015	0.017	C
Carbon Steel (Lo)	65	0.001	--	--	–	--	–	–	--	H
1010-1020	90	–	0.003	0.005	0.009	0.012	0.014	0.018	0.022	H
Carbon Steel (Med)	55	0.001	--	–	–	–	–	–	–	H
1030-1055	75	--	0.003	0.005	0.009	0.012	0.014	0.018	0.022	H
Carbon Steel (Hi) 1060-1095	45	–	0.002	0.004	0.007	0.010	0.012	0.015	0.018	H
Alloy Steel (Med C) 4130-4140	65	0.001	0.003	0.006	0.010	0.014	0.016	0.020	0.023	H
Tool Steel (HS) M-3, M-4, M-7	35	0.001	0.002	0.003	0.005	0.007	0.008	0.011	0.013	H
Stainless Steel 300 Series	120	0.001	0.003	0.006	0.010	0.014	0.017	0.021	0.025	H
Stainless Steel	100	0.001	–	--	–	–	–	–	–	H
400 Series	125	–	0.003	0.006	0.010	0.014	0.017	0.021	0.025	H

* H=High-speed steel
C=Carbide

NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.

MATERIAL	BORING DEPTH OF CUT – INCHES 0.010 Speed sfpm	 0.010 Feed ipr	 0.050 Speed sfpm	 0.050 Feed ipr	 0.100 Speed sfpm	 0.100 Feed ipr	Tool Material*
Aluminum Alloys	600	0.008	570	0.010	540	0.015	H
--Wrought	1100	0.010	1040	0.015	990	0.020	C
Brass	400	0.008	380	0.010	360	0.015	H
330-340-353	800	0.010	760	0.015	720	0.020	C
Cast Iron	140	0.006	135	0.008	125	0.010	H
Soft	460	0.008	435	0.010	415	0.015	C
Cast Iron	50	0.005	45	0.007	40	0.008	H
Hard	225	0.007	210	0.009	200	0.010	C
Carbon Steel (Lo)	125	0.005	120	0.007	110	0.010	H
1010-1020	450	0.006	425	0.010	400	0.015	C
Carbon Steel (Med)	80	0.004	75	0.005	70	0.007	H
1030-1055	320	0.005	305	0.007	290	0.009	C
Carbon Steel (Hi)	65	0.004	60	0.005	55	0.007	H
1060-1095	270	0.005	255	0.007	240	0.009	C
Alloy Steel (Med C)	80	0.005	75	0.007	70	0.008	H
4130-4140	315	0.006	295	0.009	280	0.012	C
Tool Steel (HS)	50	0.004	45	0.005	45	0.007	H
M-3, M-4, M-7	200	0.005	190	0.007	180	0.009	C
Stainless Steel	95	0.005	90	0.007	85	0.008	H
300 Series	400	0.006	380	0.009	360	0.010	C
Stainless Steel	140	0.005	130	0.007	125	0.008	H
400 Series	460	0.006	425	0.009	400	0.010	C

* H=High-speed steel
*C=Carbide

NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.

Credits: Dunn, James. Machine Shop Lathes. Stillwater: Oklahoma State Board of Vocational and Technical Education, 1983, pg. 143-146.

Oberg, Erik; Franklin D. Jones; Holbrook L. Horton. Machinery's Handbook. 21st ed. New York: Industrial Press Inc., 1979.

CALCULATE FEEDS, SPEEDS AND TIME REQUIREMENTS FOR LATHE SET-UP

To do an effective job of machining, produce the finish required and preserve maximum tool life, the machinist must ensure that the work turns at the proper rpm to obtain the correct surface feet per minute.

Use HO 1.1 to determine speeds and feeds for the following operations. For rough turning, use the existing or starting diameter; use the finish size of the part for the finish diameter. Round rpm to the nearest whole number. Show all work on a separate page.

Turn a 1 1/2" aluminum bar down to 1 1/8" diameter using high-speed steel cutting tools.

1. Rough turn = ________________ rpm
2. Finish turn = ________________ rpm
3. Rough turn = ________________ ipr
4. Finish turn = ________________ ipr
5. Total amount of material to be removed = ________________

Turn the outside diameter of a 4" hard cast-iron pipe valve to 3.875" using carbide (throw-away) cutting tools.

6. Rough turn = ________________ rpm
7. Finish turn = ________________ rpm
8. Rough turn = ________________ ipr
9. Finish turn = ________________ ipr
10. Total amount of material to be removed = ________________

Using a high-speed steel cutting tool, finish turning a brass connector with a diameter of 2.000" to a diameter of 1.950".

11. Finish = ________________ rpm
12. Feed rate = ________________ ipr
13. Amount of material to be removed with the finish cut = ________________

Bore a 3 1/2" hole 2 1/2" deep in a 300-series stainless steel bar with an existing hole of 3 1/8" diameter and 3" deep using a carbide cutting tool.

14. Roughing = ________________ rpm

15. Finishing = ________________ rpm

16. Rough bore at 0.100" deep = ________________ ipr

17. Finish bore at 0.010" deep = ________________ ipr

18. Total amount of material to be bored out = ________________

19. If two rough cuts and one finish cut are made, how much material will be removed each cut?

    a. First rough cut = ____________________

    b. Second rough cut = ____________________

    c. Finish cut = _________________________

    NOTE: The total of these three cuts should equal #18's answer.

Drill a 1 1/4" hole 3" deep in a soft cast-iron bar; the bar is 2 1/2" in diameter. Answer the following questions, assuming that a pilot hole with a 1/2" diameter is drilled first. (all drills HSS [high-speed steel])

20. What rpm will the work turn when drilling the 1/2" hole? rpm = ________

21. What rpm will the work turn when drilling the 1 1/4" hole? rpm = ______

DETERMINE CUTTING TOOL VARIABLES PRIOR TO USE

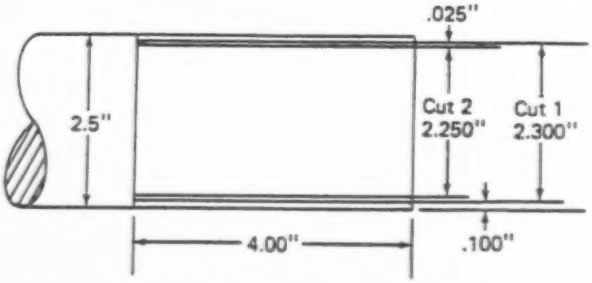
Use the formula below for calculating time to determine how long it will take to perform the following operations. Show the total time required, round answers to the nearest tenth of a minute and show calculations.

$$T = \frac{\text{Length of cut}}{\text{rpm x feed}}$$

Turn to size a 2 1/2" medium carbon-steel bar (SAE 1030) to 2.250" diameter. Procedure will require one rough cut and one finish cut, using a high-speed steel cutting tool.

1. Total time = ____________________ minutes

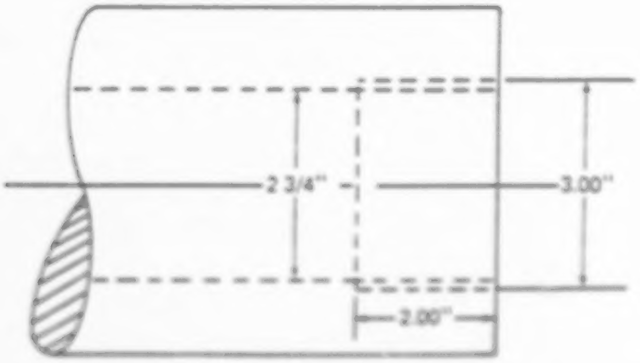
Rough turn--120 rpm
Feed--0.015 ipr
Finish turn--183 rpm
Feed--0.007 ipr



NOTE: Art for this assignment sheet is from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 188. Used with permission.

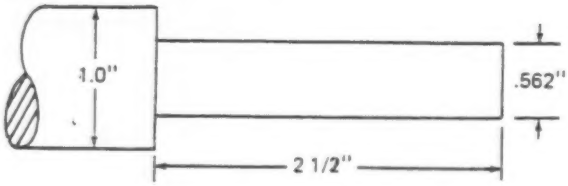
Bore a 3" diameter hole 2" deep in work that has a 2 3/4" existing hole. The material is soft cast iron and the boring bar uses carbide inserts. For this operation, use 604 rpm for roughing speed with a feed of 0.010" and 615 rpm for finishing with a feed of 0.008". Two rough cuts and one finish cut will be required.

2. Total time = ____________________ minutes



Turn a 1" aluminum bar down to 9/16" using high-speed steel cutting tools; use 2000 rpm with a 0.015" feed for roughing and 2000 rpm with a 0.007" feed for finishing. The total material to be removed is 0.438", which will require two rough cuts and one finish cut.

3. Total time = ____________________ minutes



ANSWERS TO AS 1.1

1. 1600 rpm
2. 2844 rpm
3. 0.015 ipr
4. 0.007 ipr
5. 0.375"
6. 340 rpm
7. 423 rpm
8. 0.015 ipr
9. 0.007 ipr
10. 0.125"
11. 985 rpm
12. 0.007 ipr
13. 0.050"
14. 460 rpm
15. 457 rpm
16. 0.010 ipr
17. 0.006 ipr
18. 0.375"
19. a. 0.178" or 0.200"
    b. 0.177" or 0.155"
    c. 0.020"
20. 1280 rpm
21. 512 rpm

ANSWERS TO AS 1.2

1. 5.3 minutes
2. 1.1 minutes
3. 0.4 minute

MODULE: LATHES

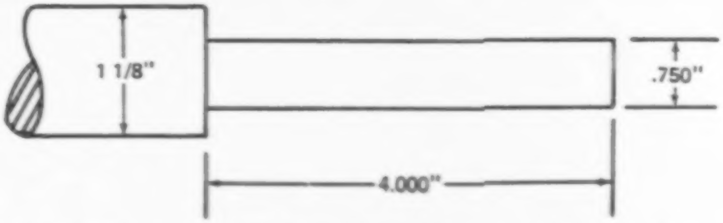
UNIT IV: LATHE CALCULATIONS

UNIT TEST

Use shop formulas and charts from HO 1.1 to determine lathe speeds, feeds and depth of cut.

NOTE: Round rpm to whole numbers; compute all feeds to the third decimal place. Use 1 1/8" diameter to calculate roughing rpm and a 3/4" diameter to calculate finish rpm. Show work on a separate sheet.

Using high-speed steel to machine 1 1/8" diameter low carbon steel (SAE 1020) round bar 7" long, compute for cutting 4" of the bar to 3/4" diameter.



NOTE: Art for this test is from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 242-244. Used with permission.

1. Roughing rpm = ______________

   a. 42
   b. 100
   c. 270
   d. 427
   e. 4,270

2. Finishing rpm = ______________

   a. 85
   b. 853
   c. 8,500
   d. 580
   e. 58

3. Roughing feed = ______________

   a. .015 ipr
   b. .0015 ipr
   c. .150 ipr
   d. 1.015 ipr
   e. .5 ipr

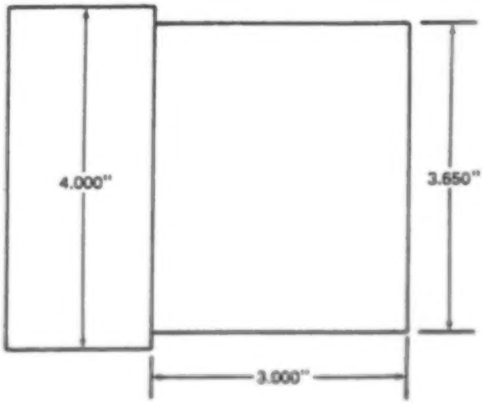
4. Finshing feed = ______________

   a. .25
   b. .0700 ipr
   c. .7007 ipr
   d. .0007 ipr
   e. .007 ipr

5. If one cut is allowed for finishing, how many rough cuts will be required before making a finih cut?

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

Using throw-away carbide, compute for cutting a 4" aluminum bar that is solution-treated and aged from 4" to 3.650" diameter; make a cut 3" long.



6. Roughing rpm = ______________

   a. 500
   b. 1,000
   c. 1,500
   d. 2,000
   e. 2,050

7. Finishing rpm = ______________

   a. 873
   b. 900
   c. 973
   d. 1,073
   e. 1,973

8. Roughing feed = ______________

   a. .020 ipr
   b. .030 ipr
   c. .040 ipr
   d. .050 ipr
   e. .060 ipr

9. Finishing feed = ______________

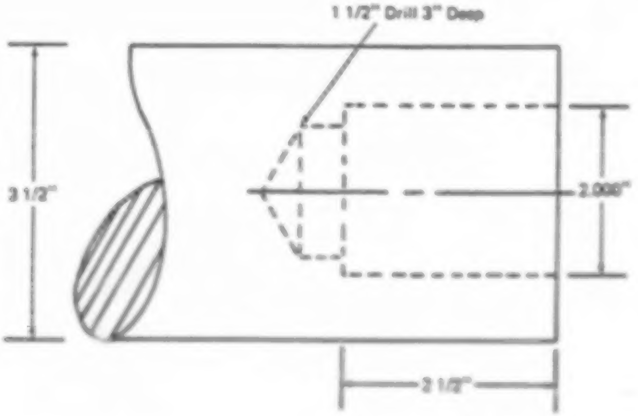
   a. .010
   b. .020
   c. .030
   d. .040
   e. .050

10. If one cut is allowed for finishing, how many rough cuts will be required before making a finish cut?

    a. 1
    b. 2
    c. 3
    d. 4
    e. 5

Using carbide boring tool (throw-away), compute for boring a 2" hole after it has been drilled to 1 1/2" diameter; material is soft cast iron.

NOTE: Using a roughing diameter of 1 1/2" and finish diameter of 2.000", round rpm to whole number.



11. Roughing rpm = ____________

a. 110
b. 407
c. 1,107
d. 1,407
e. 800

12. Finishing rpm = ____________

a. 1,407
b. 2,100
c. 520
d. 720
e. 920

13. Roughing feed = ____________

a. .010-.015
b. .002-.003
c. .004-.005
d. .006-.007
e. .008-.009

14. Finishing feed = ____________

a. .005 ipr
b. .006 ipr
c. .007 ipr
d. .008 ipr
e. .009 ipr

15. If one cut is allowed for finishing, how many rough cuts will be made (depending upon depth of roughing cuts)?

a. 1-2
b. 3-5
c. 6-7
d. 8
e. None

16. List the four factors that need to be considered when calculating machining time.

a.

b.

c.

d.

ANSWERS TO UNIT TEST

1. d (15)
2. b (15)
3. a (15)
4. e (15)
5. b (14)
6. c (15)
7. e (15)
8. a (15)
9. a (15)
10. b (14)
11. c (15)
12. e (15)
13. a (15)
14. d (15)
15. b (14)
16. a. Speed (rpm) (14)
    b. Feed rate (ipr)
    c. Length of cut
    d. Number of cuts (amount of material to be removed)

MODULE: LATHES

UNIT V: LATHE TAPER AND THREAD APPLICATIONS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to perform shop math required to calculate tapers and American National thread forms. The student should also be able to plan production operations. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms associated with engine lathe operations to definitions.

1.2 Match taper formulas to applications.

1.3 Name the parts of an American National thread form.

1.4 Identify thread forms.

1.5 Identify and use formulas to calculate dimensions for an American National thread form.

MODULE: LATHES

UNIT V: LATHE TAPER AND THREAD APPLICATIONS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: TAPER AND THREAD FORMS
    a. Informational outline
    b. Assignment sheet
        AS 1.1: Use shop formulas to calculate tapers
    c. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.
2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.
3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.
4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.
2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.
3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

    a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

    b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

    c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.

    d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

    e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

2. Audiovisuals

    a. Drilling, Reaming, and Boring on the Lathe, Part I (MS-86-355) (video). Sedalia, MO: State Fair Community College, 1986. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610)

    b. Drilling, Reaming, and Boring on the Lathe, Part II (MS-86-356) (video). Sedalia, MO: State Fair Community College, 1986. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610)

MODULE: LATHES

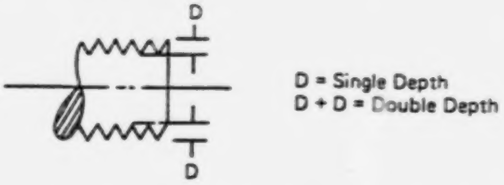
UNIT V: LATHE TAPER AND THREAD APPLICATIONS

LESSON 1: TAPER AND THREAD FORMS

I. Terms and definitions

A. Cosine--ratio of adjacent side's length to the hypotenuse

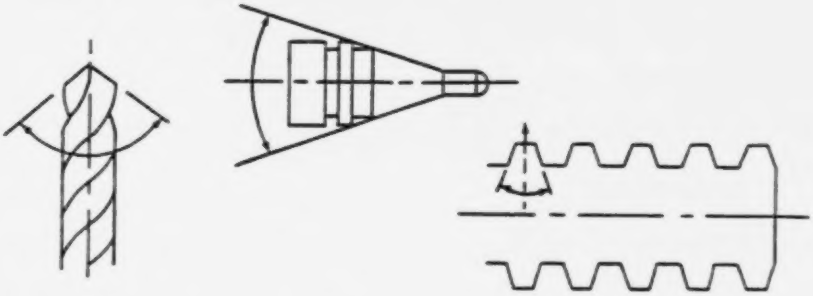
B. Double depth of thread--two times single depth of thread; sum of thread depths on each side of screw thread



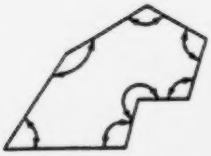
NOTE: Art in this lesson is from James Dunn's Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 261-265 and 275-283.

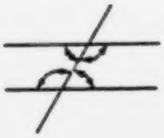
C. Hypotenuse--right triangle side which is opposite the right angle

D. Included angle--sum of two equal angles whose common side is center axis of workpiece or part of workpiece



E. Interior angle--angle that lies inside and between two adjacent lines

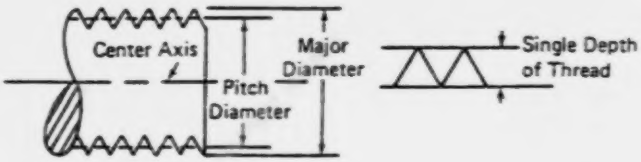




F. Limits--maximum and minimum dimensions allowed

G. Pitch--distance from point on one thread to corresponding point on next thread; measured parallel to axis of work

H. Pitch diameter--imaginary diameter equal to major diameter of threads minus single depth of thread

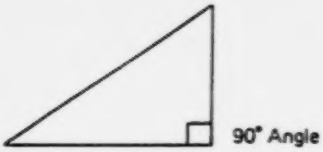


I. Reference angle--any angle used to define a dimension or give a location

J. Right angle--90° angle

K. Right triangle--triangle with two sides at 90° to each other

NOTE: Because the sum of a triangle's three angles is 180°, the sum of the two remaining angles of a right triangle is also 90°. The right angle of a right triangle is normally indicated with two short lines that form a square with the sides of the right angle.



L. Side adjacent--side of right triangle that forms one side of reference angle and one side of right angle

M. Side opposite--side of a right triangle opposite a designated reference angle; forms one side of right angle

N. Sine--ratio of side's length opposite to the hypotenuse

O. Single depth of thread--distance from top (crest) of one thread to the bottom (root) of thread perpendicular to axis of work

P. Tangent--ratio of side's length opposite to side adjacent's length

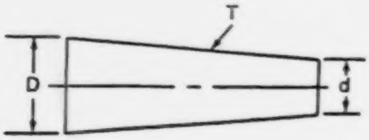
Q. Taper--uniform change in diameter of work along its axis

R. Tolerance--permissible deviation from a design dimension

S. Trigonometric function--ratio of lengths of two sides of a triangle; expressed as a decimal

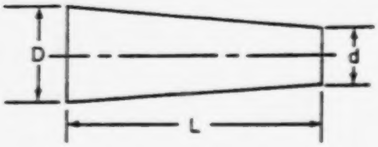
II. Applications of taper formulas

A. T = D - d is used to determine total taper of a part. Subtract small diameter (d) from large diameter (D).



B. tpi = $\frac{D - d}{L}$ is used to determine taper per inch of a part.

NOTE: To find taper per inch (tpi), subtract the small diameter (d) from the large diameter (D) and divide by the length (L) in inches of the taper parallel to the axis.

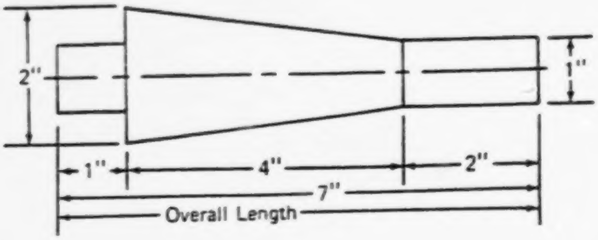


C. tpf = $\frac{D - d}{L}$ x 12 or tpf = tpi x 12 is used to determine taper per foot of a part. Subtract the small diameter (d) from the large diameter (D), divide by the length (L) of taper in inches, and then multiply by 12 or multiply the tpi by 12.

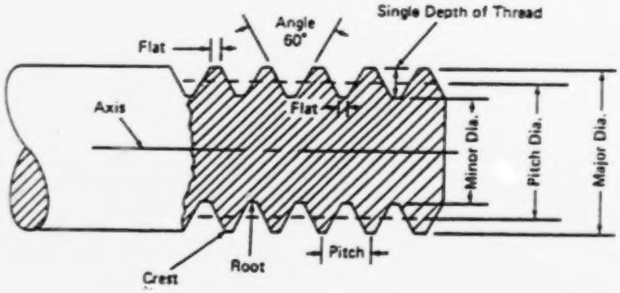
D. D = (tpi x L) + d is used to determine large diameter of a part if taper per inch and small diameter are known. Multiply the taper per inch (tpi) by the length (L) of the taper, and add the small diameter (d).

E. d = D - (tpi x L) is used to determine small diameter of a part if taper per inch and large diameter are known. Multiply the taper per inch (tpi) by the length (L) of the taper, and subtract that from the large diameter (D).

F. TO = $\frac{\text{tpi x overall length}}{2}$ is used to determine tailstock offset. Multiply the taper per inch (tpi) times the overall length of part and divide by two.

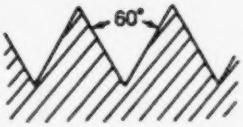

2"
1"
1"
4"
2"
7"
Overall Length

III. Parts of American National thread

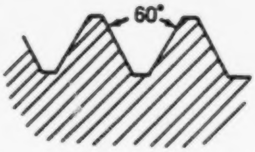

Angle 60°
Single Depth of Thread
Flat
Axis
Flat
Minor Dia.
Pitch Dia.
Major Dia.
Crest
Root
Pitch

IV. Thread forms

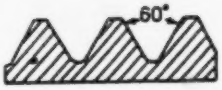
A. The sharp "V" thread form is not used much today because it is easily damaged.



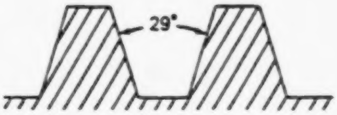
B. The American National thread form is used extensively in today's industries.



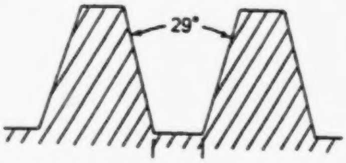
C. The Unified thread form is used as a standard form in the United States, Canada and Great Britain.



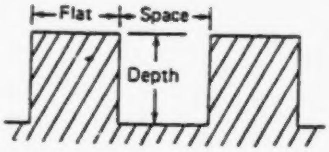
D. Acme thread forms are very strong and are a modified square thread.



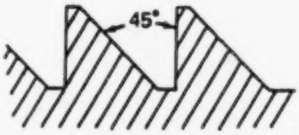
E. The Brown and Sharpe worm thread form is similar to an Acme thread in appearance but has a deeper thread; it is another form of a modified square thread.



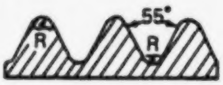
F. In the square thread, the flat, space and depth of the square thread are all equal.



G. The buttress thread form has great strength in one direction.



H. A Whitworth thread has a 55° thread angle with a radius at crest and root.



V. Calculating dimensions for American National form

NOTE: Formulas for computing thread dimensions vary with each form. Refer to appropriate handbooks to determine other required formulas.

A. Pitch (P)--P = $\frac{1}{\text{Number of threads per inch (N)}}$

EXAMPLE: To determine the pitch of a bolt with 20 American National form threads per inch

$$P = \frac{1}{N}$$

$$= \frac{1}{20}$$

$$= 0.050"$$

B. Single depth of thread (D)--D = 0.6495 x P **or** D = $\frac{0.6495}{N}$

NOTE: The number 0.6495 is a constant for the ratio of the pitch to the depth of the American National form.

EXAMPLE: To determine the single depth of thread for a bolt with 20 American National form threads per inch

$$D = 0.6495 \times P$$

$$= 0.6495 \times 0.050"$$

$$= 0.033"$$

or $$D = \frac{0.6495}{N}$$

$$= \frac{0.6495}{20}$$

$$= 0.033"$$

C. Width of flat (F)--F = 0.125 x P **or** F = $\frac{0.125}{N}$

NOTE: The number 0.125 is a constant for the ratio of the pitch to the flat of the American National form.

EXAMPLE: To determine the width of a flat on a bolt with 20 American National form threads per inch.

$$F = 0.125 \times P$$

$$F = 0.125 \times 0.050"$$

$$F = 0.006"$$

or $$F = \frac{0.125}{N}$$

$$= \frac{0.125}{20}$$

$$= 0.006"$$

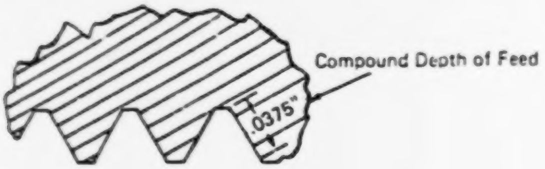
D. Compound feed depth (C)--$C = 0.75 \times P$ or $C = \frac{0.75}{N}$

NOTE: The number 0.75 represents the percent of thread engagement for American National form.

EXAMPLE: To determine the compound feed depth for cutting a bolt with 20 American National form threads per inch

$$C = \frac{0.75}{N} = \frac{0.75}{20} = 0.0375''$$

$$\text{or } C = 0.75 \times P = 0.75 \times 0.05'' = 0.0375''$$



E. Methods of measuring thread pitch diameters

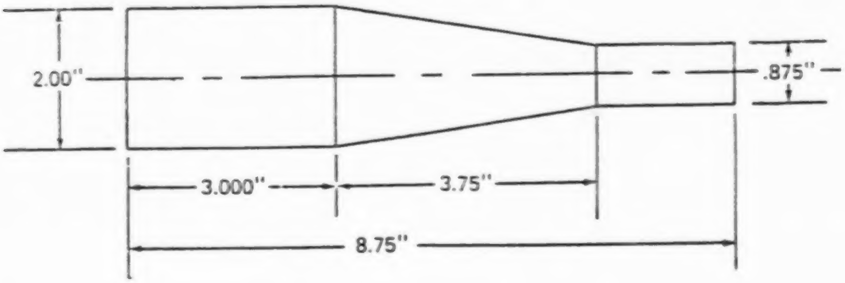
NOTE: Pitch diameters for using screw pitch micrometers are in machinery handbooks; using thread triangles or three-wire requires calculations.

1. Screw pitch micrometer
2. Thread triangles with standard micrometer
3. Three-wire with standard micrometer
4. Thread snap gages
5. Plug-on ring gages

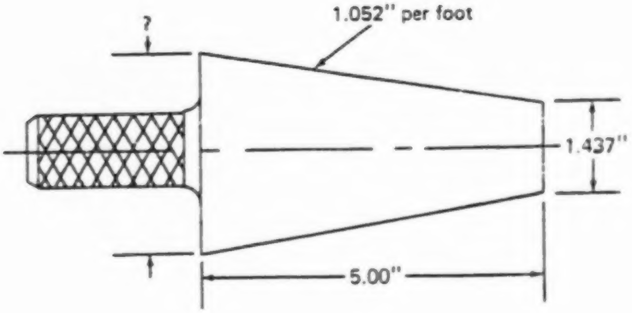
USE SHOP FORMULAS TO CALCULATE TAPERS

Determine taper dimensions for the following problems. Give answers in ten-thousandths of an inch and show calculations.

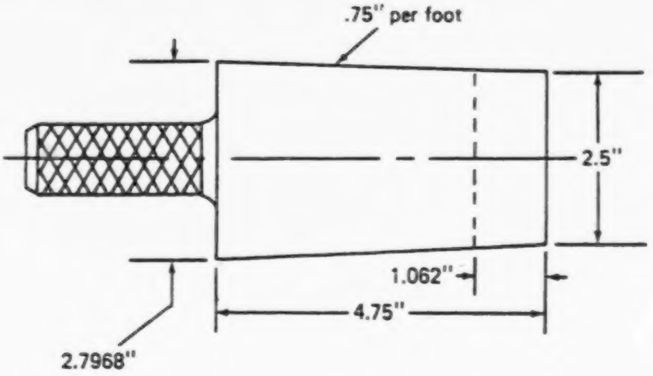
1. What is the taper per foot of the part illustrated below? ____________


2.00"
.875"
3.000"
3.75"
8.75"

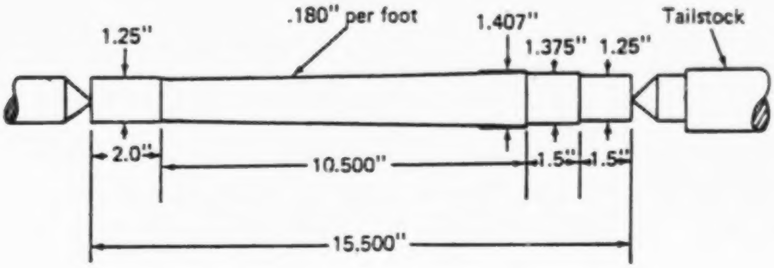
2. What is the diameter of the large end of the taper plug gage illustrated below? ____________


?
1.052" per foot
1.437"
5.00"

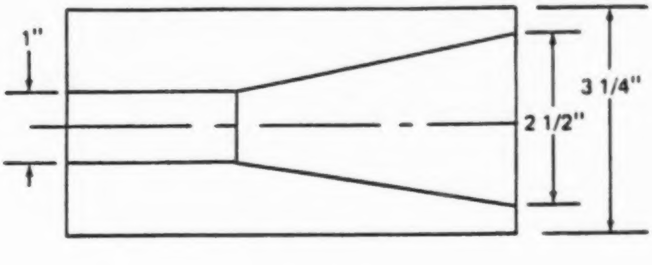
3. If the plug gage shown below fits in a mating taper and the small end extends 1.062" through the taper, what is the diameter at that point? ____________


.75" per foot
2.5"
1.062"
4.75"
2.7968"

4. How much must the tailstock offset be in order to machine the part shown below? ____________
Is the tailstock offset toward or away from you? ____________


.180" per foot
1.25"
1.407"
1.375"
1.25"
Tailstock
2.0"
10.500"
1.5"
1.5"
15.500"

5. What is the total taper of the part below? ____________



ANSWERS TO AS 1.1

1. 3.6" per foot
2. 1.8795"
3. 2.5663"
4. 0.11625", away
5. 1.5"

MODULE: LATHES

UNIT V: LATHE TAPER AND THREAD APPLICATIONS

UNIT TEST

Match the following terms and definitions.

____ 1. Two times single depth of thread; sum of thread depths on each side of screw thread

____ 2. Distance from point on one thread to corresponding point on next thread; measured parallel to axis of work

____ 3. Sum of two equal angles whose common side is center axis of workpiece or a part of workpiece

____ 4. Distance from top (crest) of one thread to the bottom (root) of thread perpendicular to axis of work

____ 5. Imaginary diameter equal to major diameter of threads minus single depth of threads

____ 6. Angle that lies inside and between two adjacent lines

____ 7. Ratio side's length opposite to the hypotenuse

____ 8. Ratio of side's length adjacent to the hypotenuse

____ 9. Ratio of side's length opposite to side adjacent's length

____ 10. Side of right triangle that forms one reference angle side and one right angle side

____ 11. Any angle used to define a dimension or give a location

____ 12. Right triangle side which is opposite the right angle

____ 13. Ratio of lengths of two sides of a triangle; expressed as a decimal

____ 14. Right triangle side which is opposite the right angle

a. Cosine

b. Double depth of thread

c. Hypotenuse

d. Included angle

e. Interior Angle

ab. Pitch

ac. Pitch diameter

ad. Reference angle

ae. Side adjacent

bc. Side opposite

bd. Sine

be. Single depth of thread

cd. Tangent

de. Trigonometric function

Select the option which answers the question or completes the statement.

____ 15. Which of the following formulas is used to determine total taper of a part?

a. T = ID - OD
b. T = D + d + 1
c. L + D = T
d. T = L x d
e. T = D - d

____ 16. Which of the following formulas is used to determine taper per inch of a part?

a. tpi = D - d + L
b. .03175 x L = tpi
c. tpi = L x D
d. .03715 x tpf = tpi
e. tpi = tpf + D + d

____ 17. Which formula is used to determine a part's taper per foot?

a. tpf = D - d x 12
b. Tpf = D - d + L x 12
c. tpf = 12 (L + d)
d. tpf = D - d + 12 x L
e. None of the above

____ 18. Which of the following formulas is used to determine taper per foot if tpi is known?

a. tpi x 12
b. Tpf - 12
c. tpi + 12
d. (D - d) + tpi
e. (D - d) x tpi

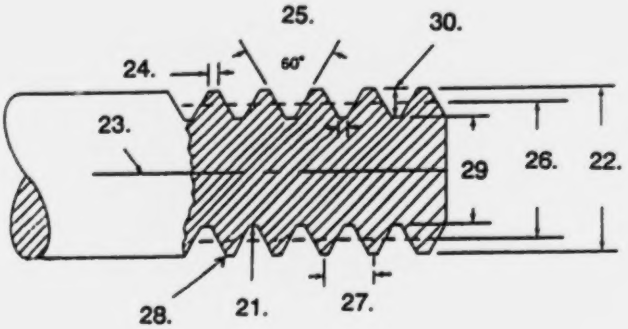
____ 19. Which formula would be used to determine the large diameter of a part if taper per inch and small diameter are known?

a. D = (tpi x L) - d
b. D = (tpi x L) + d
c. D = (d x tpi) + .31416
d. D = (tpi + L) - d
e. D = .31416 + tpi

____ 20. If taper per inch and large diameter are known, which of the following formulas is used to determine the small diameter of a part?

a. tpi - D = d
b. d = L (D - tpi)
c. d = D - (tpi x L)
d. d = D x (tpi X L)
e. tpi x (D - L) = d

Match terms with the numbered parts of an American National thread form.


25.
30.
24.
60°
23.
29
26.
22.
28.
21.
27.

___ 21.
___ 22.
___ 23.
___ 24.
___ 25.
___ 26.
___ 27.
___ 28.
___ 29.
___ 30.

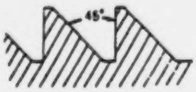
a. Angle
b. Axis
c. Crest
d. Flat
e. Major diameter
ab. Minor diameter
ac. Pitch
ad. Pitch diameter
ae. Root
bc. Single depth of thread

Identify the thread forms by matching illustrations with appropriate terms.

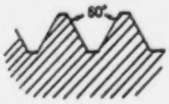
___ 31. Sharp "V"
___ 32. American National
___ 33. Unified
___ 34. Acme

___ 35. Brown and Sharpe worm
___ 36. Square
___ 37. Buttress
___ 38. Whitworth

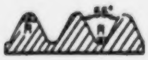
a.



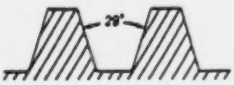
d.



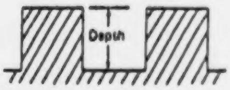
ac.



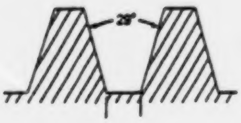
b.



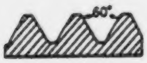
e.



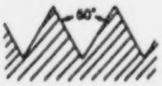
ad.



c.



ab.



Select the option which answers the question or completes the statement.

____ 39. Which of the following formulas is used to determine pitch (P) for an American National thread? (N = Number of threads per inch)

a. P = 1 ÷ N
b. P - 1 = N ÷ 1
c. P = N x 3.1416
d. P = N x 1.0
e. P = 1 ÷ L

For the next three questions, determine the pitch of the following American National form threads.

____ 40. 1/4 - 20 - NC

a. .05
b. .400
c. 5.0
d. .04
e. .005

____ 41. 5/16 - 18 - NC

a. .555"
b. .505
c. .045
d. .0555
e. .0655

____ 42. 3/8 - 16 - NC

a. .1255
b. .0625
c. .5
d. .0555
e. .6255

____ 43. Which of the following formulas is used to determine the single depth of thread of a bolt that is an American National thread form?

a. D = tpi x N
b. D = crest x root
c. D = r^2 x P
d. D = .3147 x P
e. D = .6495 x P

____ 44. Which formula is used to determine the width of a flat on a bolt that is an American National thread form?

a. F = D x .500
b. F = .125 x P
c. F = crest x m.d.
d. F = root x m.d.
e. F = .375 x P

____ 45. Which of the following formulas is used to determine compound feed depth for cutting a bolt that is an American National thread form?

a. C = degrees x P
b. C = .75 ÷ N
c. C = N ÷ m.d.
d. C = N x .375
e. C = .250 ÷ N

ANSWERS TO UNIT TEST

1. b
2. ab
3. d
4. be
5. ac
6. e
7. bd
8. a
9. cd
10. ae
11. ad
12. bc
13. de
14. c
15. e
16. a
17. b
18. a
19. b
20. c
21. ae
22. e
23. b
24. d
25. a
26. ad
27. ac
28. c
29. ab
30. bc
31. ab
32. d
33. c
34. b
35. ab
36. e
37. a
38. ac
39. a
40. a
41. d
42. b
43. e
44. b
45. b

MODULE: LATHES

UNIT VI: PLANNING CONSIDERATIONS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify the sequence of planning for lathe workpieces. The student should also be able to determine the main influences on the selection of work-holding, sequence of operations, method of operations and tool materials. This knowledge will be evidenced by achieving the specified score on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Utilize guidelines to plan sequence of machining operations. (competency D9 and F4)

1.2 Identify the main influences on the selection of angles, work-holding methods and tool material. (competency F2)

1.3 Distinguish between types of work-holding methods. (partial competency I10 and I34)

MODULE: LATHES

UNIT VI: PLANNING CONSIDERATIONS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: PLANNING AND WORK-HOLDING SELECTION

    a. Information outline

    b. Handout

    HO 1.1: Factors to consider
    HO 1.2: Selection of operation method
    HO 1.3: Tool material and angle selection

    c. Assignment sheets

    AS 1.1: Plan production operations--Pt. I
    AS 1.2: Plan production operations--Pt. II

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.
2. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.
3. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.
4. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.
5. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

MODULE: LATHES

UNIT VI: PLANNING CONSIDERATIONS

LESSON 1: PLANNING AND WORK-HOLDING SELECTION

I. Planning guidelines (HO 1.1)

  A. Check the drawing and instructions.

    1. Make sure instructions are understood.

    2. Know exactly what needs to be done to the workpiece.

  B. Check the material type and size.

    1. Do you have the right material?

    2. Are the material allowances adequate?

    3. Can it be turned safely on the lathe being used?

  C. Select the work-holding method; consider the following.

    1. Size and shape of workpiece

    2. Material form (casting, bar, stock)

    3. Quantity of workpieces required

    4. Sequence of operations

    5. Capacity

    6. Accuracy required

    7. Method of operation

  D. Select the sequence and method of operation. **(HO 1.2)**

    1. Main influences on sequence selection

      a. Operations required (threading, drilling, etc.)

      b. Accuracy required

      c. Size and shape of workpiece

      d. Material form (casting, bar, stock)

      e. Work-holding

      f. Quantity of workpieces required

      g. Method of operation

2. Main influences on the method of operation
    a. Accuracy required
    b. Sequence of operations
    c. Operations required (threading, drilling, etc.)
    d. Size and shape of workpiece
    e. Work-holding
    f. Surface finish required

E. Select the tool materials and angles.
    1. Material type (steel, brass, etc.)
    2. Quantity of workpieces required
    3. Range of speeds
    4. Material form (casting, bar, etc.)
    5. Tool shapes
    6. Rigidity
    7. Surface finish required
    8. Size and shape of workpiece
    9. The rake angle is decreased in the following situations.
        a. Increased hardness and brittleness of materials
        b. Increased hardness and brittleness of the tool material
        c. Increased turning speed

NOTE: There is no best rake angle to use unless the material type and condition, tool material type and grade are precisely known.

II. Main influences on selection of work-holding methods (HO 1.3)
    A. Size and shape of workpiece
    B. Material form (casting, bar, stock)
    C. Quantity of workpieces required
    D. Sequences of operations
    E. Capacity
    F. Accuracy required
    G. Method of operations

III. Work-holding methods and general use rules

- A. Three-jaw self-centering chuck with hard jaws
  - 1. Use for cylindrical or hexagonal work and production work (ease of setting).
  - 2. Improper uses
    - a. Rough bar or irregularly shaped work
    - b. Second operations requiring concentricity
    - c. Long work without support
    - d. Finished diameters
    - e. Gripping on short lengths
- B. Three-jaw self-centering chuck; soft-jaw
  - 1. Use for semifinished or finished work and second operations requiring concentricity.
  - 2. Do not use for gripping on non-machined surfaces or long work without support.
- C. Four-jaw independent chuck
  - 1. Uses
    - a. Very heavy cuts
    - b. Rough bar or irregular-shaped work
    - c. Symmetrical work
    - d. Eccentric work
    - e. Setting concentric work
    - f. Gripping on short lengths
  - 2. Do not use for long work without support or holding on finished work (unless suitable protection is used).
- D. Round collets
  - 1. Uses
    - a. Cold-rolled or machined bar
    - b. Production work (ease of setting)
    - c. Relatively small work
    - d. Second operations requiring concentricity

2. Improper uses
   a. Rough bar or irregularly shaped work
   b. Long work without support
   c. Work that doesn't match collet diameter

E. Collets, other cross sections
   1. Uses
      a. Cold rolled or machined work or appropriate cross section
      b. Production work (ease of setting)
   2. Improper uses
      a. Rough bar
      b. Long work without support
      c. Work of cross section size, but not of collet size

F. Between centers using follower
   1. Uses
      a. Long, shallow tapers (offsetting tailstock)
      b. Pre-machining for grinding
      c. Work requiring concentricity on all diameters
      d. Relatively long work
      e. Eccentric work
   2. Improper uses
      a. Very long, slender work without support
      b. Very heavy cuts
      c. Holding previously machined work without protection between follower and work

G. Between centers, faceplates and driveplates
   1. Uses
      a. Production work
      b. Premachining for grinding
      c. Work requiring concentricity on all diameters
      d. Relatively long work

        e. Eccentric work

    2. Do not use for work where end face must not be damaged or very long, slender work without support.

H. Faceplate

    1. Use for large work that cannot be held in a four-jaw independent chuck or indirect work-holding using angle plates, V-block, fixtures, etc.

    2. Do not use for work that can be held safely by other means.

I. Mandrels

    1. Use for machining second operations from bore.

    2. Do not use where bore is very small in relation to diameter being machined or for supporting long bores.

J. Chuck arbor for internal bores

    1. Use for machining second operation from bore or nonstandard bores.

    2. Do not use for supporting long bores.

K. Dead-center tailstocks are used for supporting long or heavy work held by any work-holding method for external operations only.

L. Rolling center tailstock

    1. Supporting uses

        a. Work for heavy cuts

        b. Work for high-speed cutting

        c. Work in conjunction with face drivers

        d. Tubes

    2. Do not use where concentricity is very important or in conjunction with a mandrel.

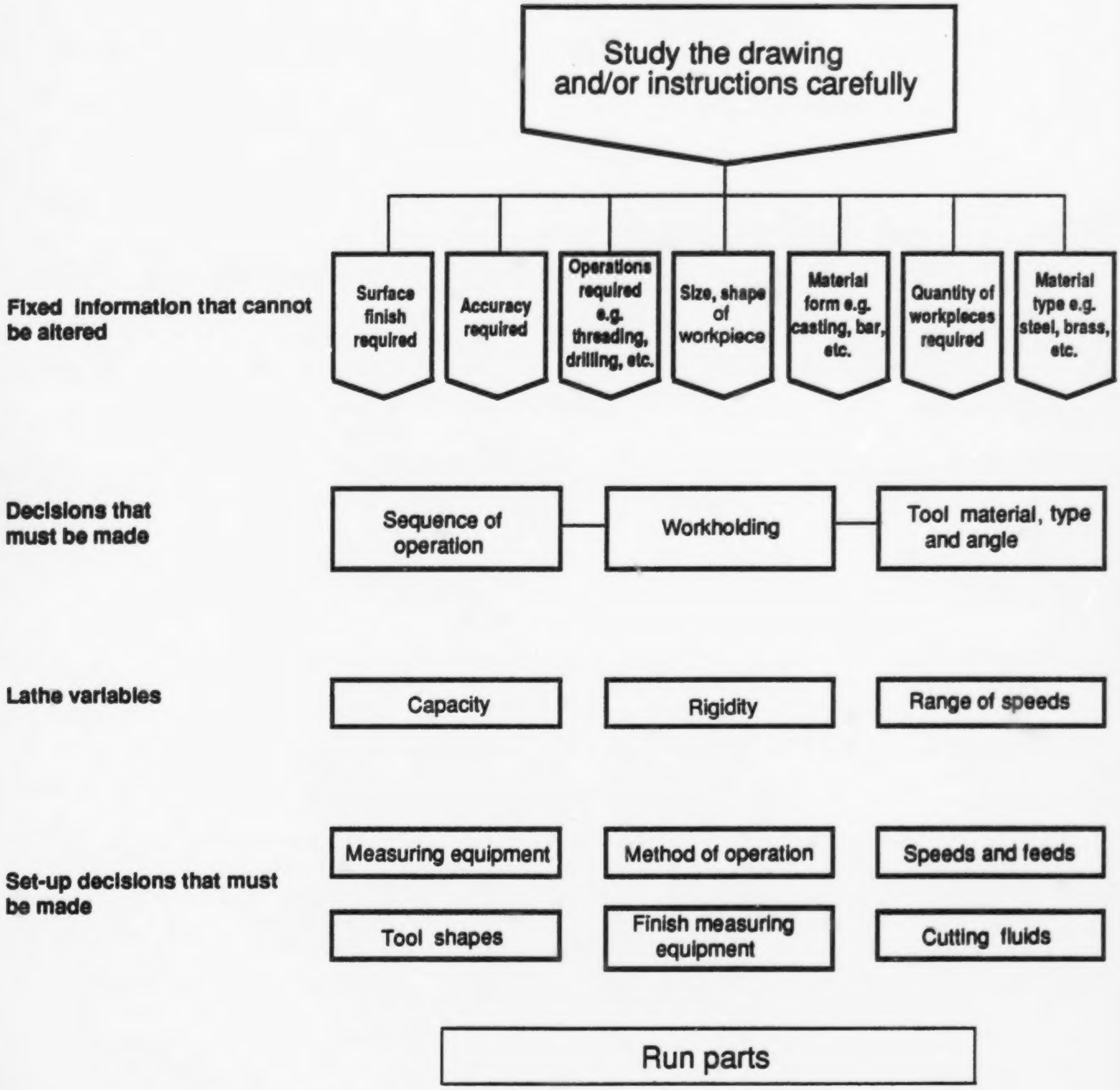
M. Steady rest can be used for supporting long concentric cylindrical work held by any work-holding method for all operations, excluding external machining full length of work in one cut. Do not use to support a rough bar.

N. Follower rest

    1. Use for machining long work in one cut.

    2. Do not use to support in advance of tool unless work has been machined and is concentric.

FACTORS TO CONSIDER


Study the drawing and/or instructions carefully
Fixed information that cannot be altered
Surface finish required
Accuracy required
Operations required e.g. threading, drilling, etc.
Size, shape of workpiece
Material form e.g. casting, bar, etc.
Quantity of workpieces required
Material type e.g. steel, brass, etc.
Decisions that must be made
Sequence of operation
Workholding
Tool material, type and angle
Lathe variables
Capacity
Rigidity
Range of speeds
Set-up decisions that must be made
Measuring equipment
Method of operation
Speeds and feeds
Tool shapes
Finish measuring equipment
Cutting fluids
Run parts

SELECTION OF OPERATION METHOD

OPERATIONS	METHOD USING	GENERAL RULES	
		ADVANTAGES	LIMITATIONS
Producing tapers	Form tools.	Any angle. Ease of setting. Repeatability.	Short tapers only.
	Compound slide.	Any angle. Ease of setting.	Short tapers only. Hand traverse only. Clearance for compound slide.
	Taper turning attachment.	Ease of setting. Automatic traverse. Repeatability.	Angles less than 20° only (approximately).
	Offset tailstock.	Long tapers. Automatic traverse.	Shallow tapers only. External only. Setup time.
	Tapered reamers.	Accuracy. Ease of use.	Standard sizes only. Internal only.
Producing threads	Single-point tool.	Any thread form.	No crest radius. Time.
	Machine chasing.	Ready ground. Full form.	Length of cutting edge.
	Hand chasing.	Finishing of small mating threads.	Small work only. Repeatability.
	Die box, tailstock die holder, or taps.	Speed. Repeatability. Ease of setting.	Standard forms only. Relatively small sizes only.
Producing multilead threads	Compound slide.	Ease of setting.	Inaccurate.
	Spindle gear.	Accuracy.	Setup time.
Knurling	Side knurls.	Ease of setting. Long lengths.	Repeatability. Relatively large diameters only. Heavy pressure required.
	Box knurls.	Repeatability. Small diameters.	Short lengths only. Setup time.

Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

OPERATIONS	METHOD USING	GENERAL RULES	
		ADVANTAGES	LIMITATIONS
Forming	Form tools.	Ease of setting. Repeatability.	Short cutting edge.
	Hand manipulation.	Ease of setting.	Inaccurate. Not repeatable.
	Forming plates.	Accuracy. Repeatability.	Setup time.
	Generation.	Accuracy. Repeatability.	Constant radii profiles only. Setup time.
	Hydraulic attachment.	Accuracy. Repeatability. Ease of operation.	Steep angles and square faces toward chuck are not possible.
Producing holes	Twist drills.	Speed. Availability for most diameters.	Relatively inaccurate. Poor surface texture. Relatively short holes only.
	Core drills.	Speed. Corrects eccentricity.	Enlarging existing holes only. Relatively short holes only.
	Spade drills.	Long holes.	Incorrect speed.
	Gun drills.	Long holes. Accuracy. Corrects eccentricity.	Serviceability. Enlarging existing holes only.
	Solid reamers.	Repeatability. Accuracy.	Enlarging existing holes only. Standard sizes only. Relatively short holes only.
	Expanding reamers.	Adjustable. Accuracy.	Enlarging existing holes only. Short holes only. Setup time.
	Floating reamers.	Adjustable. Lines up to previously machined bore. Accuracy.	Relatively short holes only. Setup time. Enlarging existing holes only.
	Shell reamers.	Long holes. Accuracy.	Standard sizes only. Setup time. Enlarging existing holes only.
	Single-point tools.	Any size. Corrects eccentricity.	Setup time. Enlarging existing holes only.

Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985. Reprinted by permission of John Wiley & Sons, Inc.

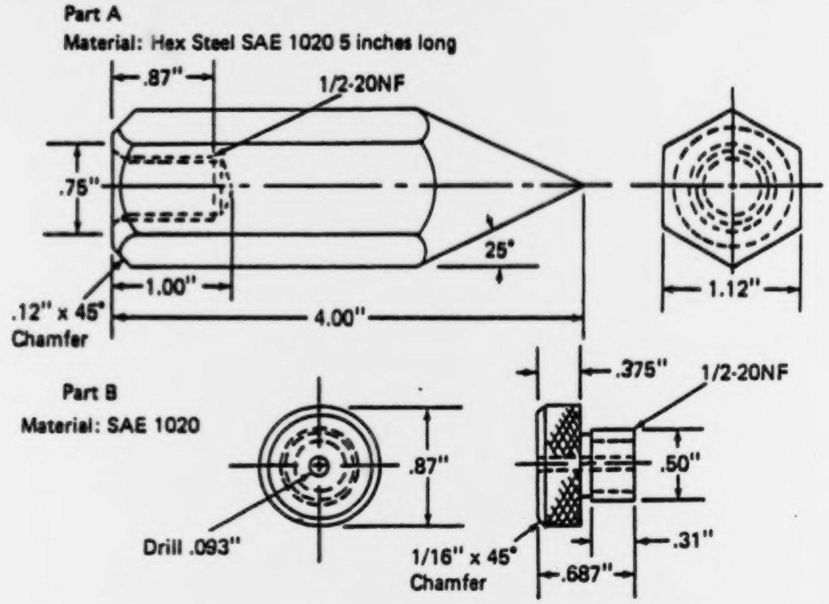
TOOL MATERIAL AND ANGLE SELECTION

TOOL MATERIAL	GENERAL RULES	
	ADVANTAGES	LIMITATIONS
High speed steel	General purpose work. Relatively low production runs. Good for intermittent cutting, high shock loading values. Easily ground and formed to shape. Accuracy on small diameter work due to use of greater rake angles.	Slow and medium cutting speeds. Excessive wear on materials with very low machinability indexes or cast surfaces.
Tungsten carbide	On materials with low machinability indexes and cast surfaces. Rapid stock removal using relatively high speeds. Negative rake cutting can be employed—high compressive strength.	Not suitable for very small diameters. Correct grade of carbide must be used. Correct style for interrupted cuts must be used.
Ceramics	On materials with low machinability indexes. Very rapid stock removal high speeds. High wear resistance. Long production runs.	Not suitable for small diameters or interrupted cuts. Poor shock resistance. Very high cutting speeds must be used. Machine must be rigid. *Note*: This material is very seldom used on most small to medium swing lathes because of insufficient speed or rigidity.
Solid	Can be ground to any shape. Obtained in round, square, or rectangular section.	Expense. Obtainable only in high speed steel.
Brazed or centered	Standard ready ground tool shapes.	Obtainable only in tungsten carbide and other sintered materials.
Indexable tip	Standard tool shapes. Ease of resetting tip. No regrinding. Chipbreaker incorporated in clamp or tip.	Initial expense. Obtainable only in tungsten carbide or ceramic tips. Rake and clearance angles constant.

Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985. Reprinted by permission of John Wiley & Sons, Inc.

PLAN PRODUCTION OPERATIONS--PT. I

Examine the blueprint below. Place an "a" before the cutting, measuring and set-up tools that would be required to make this plumb bob on an engine lathe. Place a "b" before nonessential tools.


Part A
Material: Hex Steel SAE 1020 5 inches long
.87"
1/2-20NF
.75"
25°
1.00"
.12" x 45° Chamfer
4.00"
1.12"
Part B
Material: SAE 1020
.87"
Drill .093"
.375"
1/2-20NF
.50"
.31"
1/16" x 45° Chamfer
.687"

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 297.

____ 1. Center drill, #3

____ 2. Micrometer, 1-2"

____ 3. Center gage

____ 4. Micrometer, 0-1"

____ 5. Drill, 1/2"

____ 6. Turning tool

____ 7. Recessing tool

____ 8. Protractor

____ 9. Threading tool

____ 10. Knurling tool

____ 11. Drill, 3/32"

____ 12. Drill, 27/64"

____ 13. Facing tool

____ 14. Tap, 1/2" 20-NF

____ 15. Countersink, 3/4"

____ 16. Tap handle

____ 17. Cutoff tool

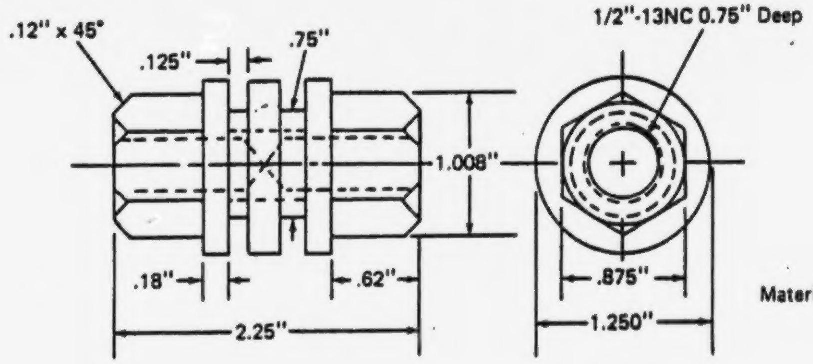
____ 18. Vernier calipers

AS 1.2

PLAN PRODUCTION OPERATIONS--PT. II

On the form that follows, sequence the steps required to make the flange nuts from the drawing below. Provide your reasoning for your sequencing. (Answers may be used more than once.)

NOTE: The steps listed are for lathe work only. Disregard the hex finish.



Material--1 1/4" steel bar, SAE 1140
Sawed length 2 3/8"

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 298.

a. Center drill
b. Turn to 1.008" diameter x 0.62"
c. Tap 1/2" - 13 NC x 3/4" deep
d. Turn end for end
e. Face
ab. Drill 27/64" x 1 3/32" deep
ac. Cut recess 0.125" x 0.025" deep
ad. Chamfer 0.12 x 45°
ae. File sharp edges
bc. Chuck

Step	Answer code	Operation	Reasoning
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

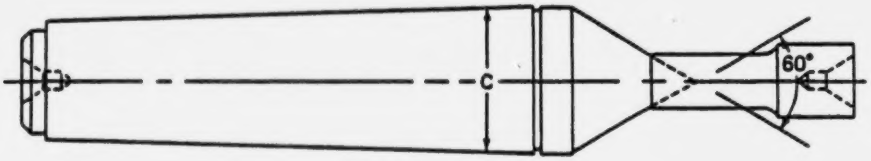
16. ________ ________ ________

17. ________ ________ ________

18. ________ ________ ________

Examine the blueprint of the dead center. Then write an "a" in the blanks before the lathe attachments and work-holding devices used to make the part illustrated below. Write a "b" if it is not required.

NOTE: Material is SAE 1095 steel rod.



Credit: Dunn, James. Machine Shop Lathes. **Stillwater:** Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 299.

____ 19. Four-jaw chuck

____ 20. Three-jaw chuck

____ 21. Collet attachment

____ 22. Drill chuck

____ 23. Live center for tailstock

____ 24. Lathe dog

____ 25. Follower rest

____ 26. Taper attachment

____ 27. Driveplate and spindle adapter

____ 28. Dead center

____ 29. Faceplate

ANSWERS TO AS 1.1

NOTE: Tools, equipment and procedures can vary, depending on tools and equipment available and the instructor's preferences. The following are suggested answers.

1. a
2. b
3. a
4. a
5. b
6. a
7. a
8. b
9. a
10. a
11. a
12. a
13. a
14. a
15. a
16. a
17. a
18. a

ANSWERS TO AS 1.2

INSTRUCTOR'S NOTE: The answers given below are only a guideline. Use student answers in the operation and reasoning columns to justify any differences from this key.

Step	Answer code	Operation
1.	bc	Chuck
2.	e	Face
3.	b	Turn
4.	ad	Chamfer
5.	a	Center drill
6.	ab	Drill
7.	c	Tap
8.	ac	Cut recess
9.	ae	File
10.	d	End for end
11.	e	Face
12.	b	Turn
13.	ad	Chamfer
14.	a	Center drill
15.	ab	Drill
16.	c	Tap
17.	ac	Cut recess
18.	ae	File

19. a
20. b
21. a
22. a
23. b
24. a
25. a
26. b
27. a
28. a
29. a

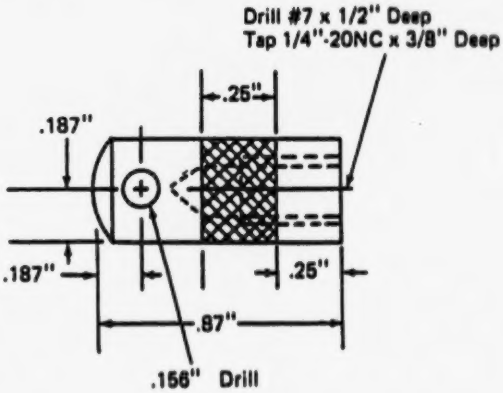
MODULE: LATHES

UNIT VI: PLANNING CONSIDERATIONS

UNIT TEST

Sequence the step-by-step lathe operations that would be required to make the keyring shown below. The following list of steps can be used to produce part A. (Answers are used only once.)

a. Turn radius to 3/4"
b. Drill #7 x 1/2" deep
c. Knurl with fine tool
d. Tap with 1/4" - 20 NC plug tap
e. Chuck in collet or three-jaw chuck
ab. Turn to .374" diameter
ac. Part off with cutoff tool
ad. Face end with right-hand facing tool
ae. Drill .156" hole with mill or drill
bc. Turn end-for-end in chuck

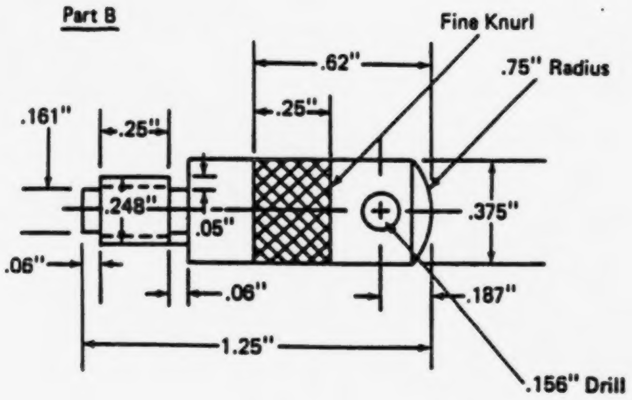


Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 292.

Step	Answer code	Operation	Reasoning
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Sequence the step-by-step lathe operations required to make the keyring shown below. The following list of steps can be used to produce part B. (Each answer is used only once.)

- a. Knurl with fine tool
- b. Face with right-hand facing tool
- c. Part off with cut-off tool
- d. Chuck in collet or three-jaw chuck
- e. Recess to .148"
- ab. Turn radius to 3/4"
- ac. Turn to .374 diameter
- ad. Cut 1/2" x 20 NC threads
- ae. Drill .156" hole with mill or drill



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 292.

Step	Answer code	Operation	Reasoning
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

Select the option which best answers the question or completes the statement.

____ 10. Which work-holding method is used for machining second operations from bore?

- a. Three-jaw self-centering chuck with hard jaws
- b. Four-jaw independent chuck
- c. Round collets
- d. Faceplate
- e. Mandrels

____ 11. Which work-holding method is used for large work that cannot be held in a four-jaw independent chuck or indirect work-holding using angle plates, V-block, fixtures, etc.?

- a. Three-jaw self-centering chuck with hard jaws
- b. Four-jaw independent chuck
- c. Round collets
- d. Faceplate
- e. Mandrels

____ 12. A round collet would be best used with which type of workpiece?

a. Irregularly shaped work
b. Long work without support
c. Work with diameters larger than the collet
d. Relatively small work
e. None of the above

____ 13. Regarding rake angle, which statement is false?

a. A good rake angle can be selected without knowing material type or condition.
b. Rake angle decreases as turning speed increases.
c. Rake angle decreases as tool material brittleness increases.
d. Rake angle decreases as material hardness increases.
e. Material type and tool material grade are necessary to choose the best rake angle.

____ 14. When properly used, which cutting tool can be do more than enlarge existing holes?

a. Expanding reamer
b. Gun drill
c. Shell reamer
d. Single-point tool
e. Twist drill

____ 15. Which tool material would not work well for machining hard materials?

a. High-speed steel
b. Tungsten carbide
c. Ceramics
d. Brazed
e. All of the above

____ 16. Which is not a consideration when describing the machinability of a material?

a. Cutting speed
b. Force required to machine
c. Expense involved
d. Surface finish
e. Tool life

INSTRUCTOR'S NOTE: Completion of this test to specified score is the student's final evaluation for competency D9: Plan sequence of machining operations.

ANSWERS TO UNIT TEST

INSTRUCTOR'S NOTE: Tools, equipment and procedures may vary, depending on tools and equipment available and the instructor's preferences. The following are suggested answers. Use student answers in the operation and reasoning columns to justify differences from the key.

Part A (D9)

Step	Answer code	Operation
1.	e	Chuck
2.	b	Drill
3.	d	Tap
4.	bc	End for end
5.	ab	Turn
6.	ad	Face
7.	a	Turn radius
8.	c	Knurl
9.	ac	Part off
10.	ae	Drill .156"

Part B (D9)

Step	Answer code	Operation
1.	d	Chuck
2.	b	Face
3.	ab	Turn radius
4.	a	Knurl
5.	ac	Turn
6.	ad	Thread
7.	e	Recess
8.	c	Part off
9.	ae	Drill .156"

10. e (I34)

11. d (I10

12. d (I10)

13. a (F4)

14. e (F4)

15. a (F2)

16. c (F2)

MODULE: LATHES

UNIT VII: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to select and apply cutting fluids, align lathe centers and remove and replace gap. This knowledge will be evidenced by performance of the job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Identify the main influences and functions of cutting fluids.

1.2 Identify major cutting fluid types and general use rules.

1.3 Select and apply cutting fluids. (competency I7, JS 1.1)

1.4 Identify lathe center alignment techniques.

1.5 Align lathe centers using test bar and dial indicator. (competency I3, JS 1.2)

1.6 Remove and replace gap. (competency I3, JS 1.3)

MODULE: LATHES

UNIT VII: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

  1. Lesson 1: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

    a. Information outline

    b. Job sheets

      JS 1.1: Select and apply cutting fluids
      JS 1.2: Align lathe centers using test bar and dial indicator
      JS 1.3: Remove and replace gap

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

  1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

  2. Kibbe, Richard R. Grinding Machine Operations. New York: John Wiley and Sons, 1985.

  3. Krar, S. F., J. W. Oswald and J. E. St. Amand. Technology of Machine Tools. 3rd ed. Toronto: McGraw-Hill, 1984.

  4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

  1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

  2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

  3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I. New York: McGraw-Hill, 1960.

d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

MODULE: LATHES

UNIT VII: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

LESSON 1: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

I. Main influences and functions of cutting fluids

  A. Main influences on cutting fluid selection

    1. Material type (steel, brass, etc.)
    2. Tool material, type and angles
    3. Quantity of workpieces required
    4. Speeds and feeds
    5. Tool shapes
    6. Surface finish required

  B. Main functions of cutting fluids

    1. Cool the workpiece
    2. Lubricate the chip-bearing surface of the tool
    3. Obtain better surface finishes
    4. Help in chip removal
    5. Protect the machine and/or equipment
    6. Protect the operator from extra fine chips (dust)

II. Major types of cutting fluids

  A. Soluble oil and water emulsions

    1. Oil-to-water ratios range between 1:5 and 1:100.
    2. Ratios of 1:25 and 1:30 are the most common applications.

  B. Straight-cutting oils

    1. Straight mineral oil
    2. Mixtures of mineral and fatty (animal) oils
    3. Sulfurized or sulfured oils
    4. Sulfurized chlorinated oils

C. Chemical solutions (without oils)

NOTE: Soluble oil and water emulsions are used mainly for their cooling properties while sulfurized chlorinated oils are used for their high chip-lubricating properties.

III. General use rules

A. Soluble oil and water emulsions

1. Add oil to water.
2. Use clean water.
3. Use recommended ratios.
4. Wipe machine slide ways and ferrous components after using high water-ratio emulsions.
5. Use special emulsion types for cast iron, lead, zinc, copper, aluminum, titanium and their alloys.

B. Do not use soluble oil and water emulsions under certain conditions.

1. When machining magnesium alloys (risk of fire)
2. On very tough materials
3. When machining with high contact-area form tools
4. With sintered tools unless coolant supply is constant

C. Sulfurized and sulfurized chlorinated oils

1. Retain oil coolness by keeping the sump full and supply abundant and constant.

   NOTE: Chlorinated oils are particularly susceptible to overheating.

2. Do not use:
   a. On PVC, PTFE, polythene and polystyrene
   b. When machining magnesium alloys (fire risk)
   c. On copper alloys if untarnished surface is required
3. Check with supervisor before using oils on other plastics or other sintered components.

D. General safety notes

1. Magnesium alloys can be machined wet using special low viscosity oils with less than 0.2% acid content, but always check with supervisor.
2. Use compressed air, water or soap solutions on polyvinyl chloride (PVC), polytetrafluorethylene (PTFE), polythene and polystyrene.
3. On other plastics, higher speeds can be employed when using cutting fluids. Always check type with supervisor.

4. On sintered components (sponge-like structure), chemical solutions that evaporate after use should be chosen. Always check type with supervisor.

5. Replace cutting fluids at recommended intervals to avoid contamination.

6. Wherever possible, machining should be carried out using cutting fluids.

IV. Alignment of lathe centers

NOTE: To provide for equal-sized diameters on the ends of long workpieces, lathe centers must be aligned before any machining is accomplished. Follow the steps below.

A. Fit live center.

1. Clean bore in machine spindle and check for burrs.

2. Clean tapered bushing and check for burrs.

3. Clean center and check for burrs.

4. Fit bushing in machine spindle.

5. Fit soft center in bushing.

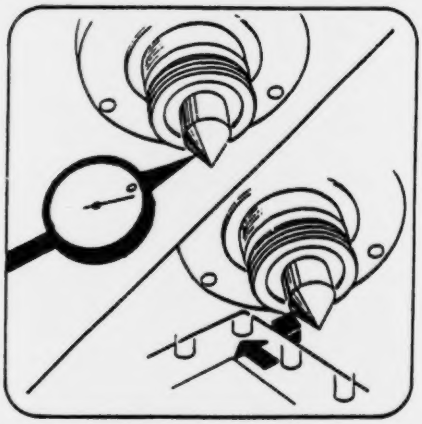
B. Check concentricity of live center. (The headstock center revolves with the machine spindle and is called the live center.)

1. Position dial indicator on center.

2. Place spindle in neutral.

3. Rotate machine spindle by hand, noting indicator movement.

NOTE: If any movement is shown, the center must be trim cut at the proper angle to obtain concentricity.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 52. Reprinted by permission of John Wiley & Sons, Inc.

C. Fit dead center. (The tailstock center does not rotate and is called the dead center.) A rolling tailstock center will greatly simplify machining on the lathe.

1. Clean taper in tailstock spindle and check for burrs.

2. Clean center and check for burrs.

3. Fit center into tailstock spindle.

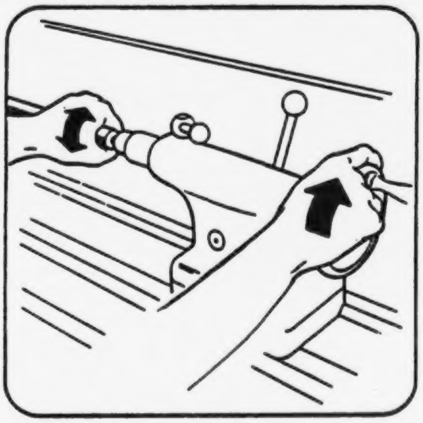
D. Set test bar between centers.

1. Clean center holes in test bar and oil lightly.

2. Set extension of tailstock spindle by same amount that will be used when turning workpiece.

3. Locate test bar on live center.

4. Slide tailstock toward test bar and support on dead center; clamp in position.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 52. Reprinted by permission of John Wiley & Sons, Inc.

5. Adjust the tailstock handwheel lock to give correct feel when rotating test bar by hand. The test bar will rotate without evident end play.

E. Check alignment.

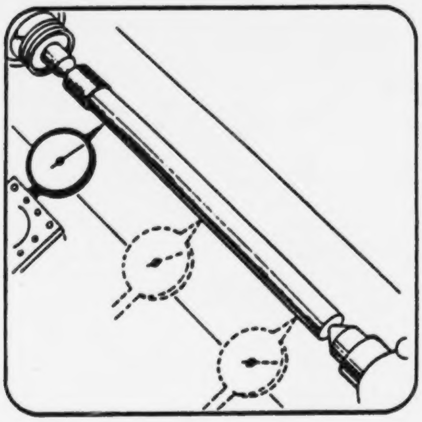
1. Clamp dial indicator in tool post and position square to test bar; ensure that stylus is horizontal and at center height.

2. Move carriage to left-hand end of ways until dial indicator is at headstock end of test bar.

3. Adjust cross slide to give half turn on dial indicator needle.

4. Zero dial indicator.

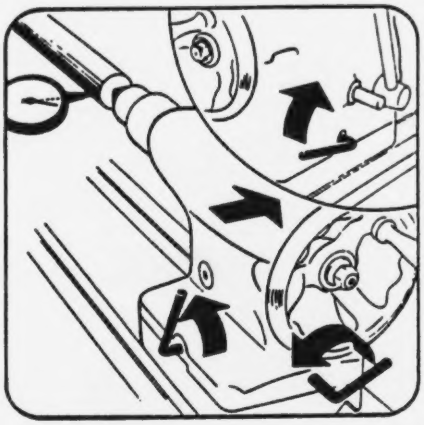
5. Move carriage toward tailstock, noting any variation of reading. Note direction and amount of error.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 54. Reprinted by permission of John Wiley & Sons, Inc.

F. Reset tailstock.

1. Set dial indicator stylus against right-hand end of test bar.
2. Zero dial indicator.
3. Loosen locking screw under tailstock hand wheel.
4. Loosen tailstock lock but retain enough pressure on the lock to prevent movement along the ways.
5. Loosen set screw at front of tailstock.
6. Tighten set screw at rear of tailstock, noting movement on the dial indicator.



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7. Tighten locking screw under handwheel when the needle moves the same amount as the error found.

8. Secure tailstock lock while watching indicator dial to ensure no movement on needle.

9. Recheck alignment of centers.

V. Gap bed lathe removal and replacement

NOTE: On a gap bed lathe, a section of the bedway can be removed, thus permitting a larger diameter workpiece to be turned. Although the length of the workpiece is limited by the width of the bedway gap, this feature often increases the versatility of the standard lathe. Follow the steps below.

A. Prepare to remove gap.

1. Consult manufacturer's handbook to find out whether the gap is keyed or dowel-pinned and in which direction.

2. Loosen and remove securing bolts.

3. Position hoist device (if necessary).

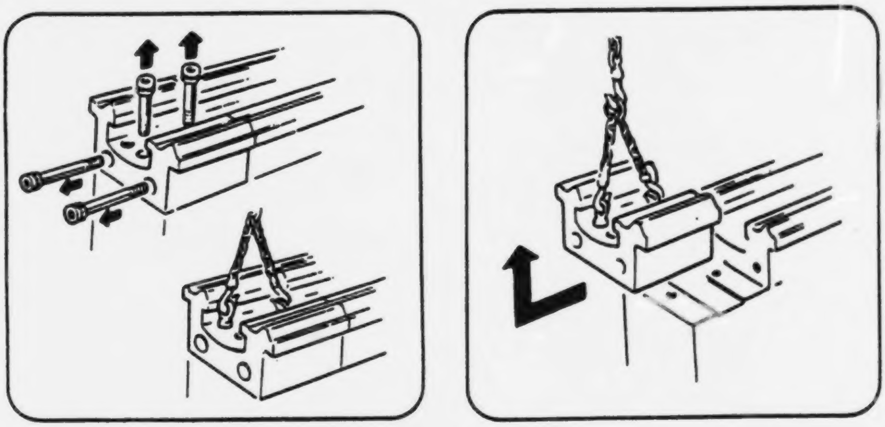
4. Screw in eyebolt if gap is tapped to take one. If not, carefully place lifting sling to balance gap when lifted.

5. Attach hoist lifting hook to eyebolt or sling.

B. Remove gap.

1. Take up slack on sling.

2. If doweled horizontally, move gap sideways to clear keys or dowels.



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3. Lift clear of bed.

C. Store gap.

1. Lower on suitably sized piece of wood to prevent damage. Remove sling and eyebolts.

2. Place securing bolts in holes to prevent loss.

3. Ensure that the gap is stored properly to prevent damage.

D. Prepare to replace gap.

1. Clean lathe bed where gap is to fit, making sure that all dirt and chips are removed.
2. Clean dowels on keys and mating face of gap.
3. Fit eyebolts and position hoist.
4. Attach lifting sling or attach hook to eyebolt.

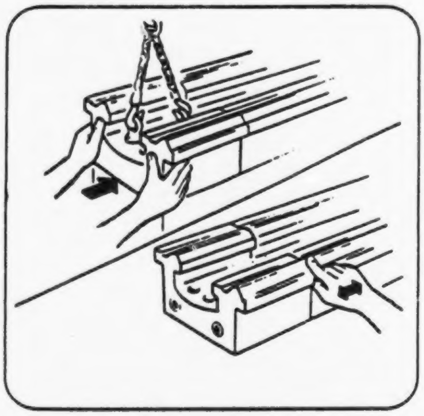
E. Take up slack in hoist and sling; lift gap.

F. Position and replace gap.

1. Lower gap slowly toward mating face.
2. Line up dowel holes or key ways.
3. Push gap to locate dowels or key ways.
4. Check that ways line up. (If they do not, strike lightly with a rawhide hammer in the direction required.)
5. Release sling and remove eyebolts.

G. Secure in position.

1. Swing hoist clear.
2. Screw in bolts and finger-tighten.
3. Tighten bolts.



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H. Final check

1. Run finger over the way joint faces to check alignment.

2. If not exactly in line, release bolts approximately a quarter-turn.
3. Tap gap with rawhide hammer in direction required.
4. Tighten bolts and recheck.

JS 1.1

SELECT AND APPLY CUTTING FLUIDS

Equipment:

Measuring cup
Five-gallon container
Water-soluble cutting fluid
Stir paddle
Pour funnel

INSTRUCTOR'S NOTE: This activity can be performed on any lathe and may be delayed according to needed maintenance schedule.

		Evaluation			
Procedure:		3	2	1	N
1.	Obtain manufacturer's specifications for lathe. Turn off power/coolant pump. Obtain five-gallon coolant container and measuring cup.	___	___	___	___
2.	If required, disconnect pump drain hose and wipe out reservoir with proper cloth or brush.	___	___	___	___
3.	Measure oil-soluble solution. Mix coolant with paddle.	___	___	___	___
4.	Using funnel, pour cutting fluid into reservoir to proper level and replace reservoir drain hose.	___	___	___	___
5.	Turn on power to lathe and coolant pump.	___	___	___	___
6.	Return all containers, measuring cups and tools to proper storage area. Wipe up any spills, sweep area clean and carefully discard refuse.	___	___	___	___
Average of above evaluations*		___	___	___	___

*This average is the student's final evaluation for competency I7: Select and apply cutting fluids.

JS 1.2

ALIGN LATHE CENTERS USING TEST BAR AND DIAL INDICATOR

Equipment:

Dead center with sleeve bushing
Revolving tailstock center
Dial indicator
Test bar 12"
Wiping cloth
Hex key set
Wipe cloth
Fine oilstone

INSTRUCTOR'S NOTE: The student must align lathe centers within 0.001" total indicator reading before receiving credit. Disalign tailstock before student begins.

	Evaluation			
Procedure:	3	2	1	N
1. Fit live center. Clean bore in machine spindle and check burrs. Clean tapered bushing and check for burrs. Clean center and check for burrs; fit bushing in machine spindle and soft center in bushing.	___	___	___	___
2. Check concentricity of live center. Position dial indicator on center; place spindle in neutral. Rotate machine spindle by hand, noting indicator reading.	___	___	___	___
3. Fit revolving tailstock center. Clean taper in tailstock center and check for burrs. Clean center and check for burrs. Fit center into tailstock spindle.	___	___	___	___
4. Set test bar between centers. Clean center holes in test bar and oil lightly. Set extension of tailstock spindle by same amount that will be used when turning workpiece. Locate test bar on live center and slide tailstock toward test bar, then clamp in position. Adjust the tailstock lock handwheel to give correct feel when rotating test bar by hand.	___	___	___	___
5. Check alignment. Clamp dial indicator in tool post and position square to test bar; set horizontal and at center height. Zero dial indicator; move carriage toward tailstock, noting variation in reading.	___	___	___	___
6. Reset tailstock. With stylus against right-hand end of test bar, loosen locking screw under tailstock handwheel. Loosen tailstock lightly; loosen set screw at front of tailstock. Tighten necessary set screw, noting movement on the dial indicator until required misalignment is corrected. Repeat until needle moves by the same amount as the error that was found. Tighten locking screws and tailstock lock.	___	___	___	___
7. Clean up area and return equipment to its proper storage location.	___	___	___	___

Average of above evaluations*

*This average is the student's partial evaluation for competency I3: Align lathe centers using test bar and dial indicator.

REMOVE AND REPLACE GAP

Equipment:

Set of hex key wrenches
Hoist device
Manufacturer's handbook
Lifting sling with eyebolts
Protective board
Rawhide hammer
Wipe cloth
Fine oilstone

INSTRUCTOR'S NOTE: To prevent damage to the lathe gap, the instructor may elect to have teams of 2-3 persons complete the procedure.

		Evaluation			
Procedure:		3	2	1	N
1.	Prepare to remove gap. Consult manufacturer's handbook for keyed or dowel-pinned construction. Loosen and remove securing bolts. Position hoist device; screw eyebolts or position sling. Attach hoist lifting hook to eyebolts or sling.	___	___	___	___
2.	Remove gap. Take up slack on sling; lift gap clear of bed. (Move gap sideways if doweled horizontally.)	___	___	___	___
3.	Store gap. Lower on suitable protective board, placing in holes for protection.	___	___	___	___
4.	Prepare to replace gap. Clean lathe bed where gap is to fit, removing all dirt and chips. Clean dowels or keys and mating face of gap. Fit eyebolts and position hoist. Attach sling or attach tool to eyebolts.	___	___	___	___
5.	Lift gap. Take up slack in hoist and sling; lift gap.	___	___	___	___
6.	Position and replace gap. Lower gap slowly toward mating face. Line up dowel holes or key ways. Push gap to locate dowels or key ways. Check that ways line up; release sling and remove eye bolts.	___	___	___	___
7.	Secure in position. Swing hoist clear; screw in bolts and finger-tighten; tighten bolts.	___	___	___	___
8.	Final check. Run finger over joint faces to check alignment. If not exactly in line, release bolts approximately a quarter-turn, tap gap with rawhide hammer in direction required, tighten bolts and recheck.	___	___	___	___
9.	Return equipment to its proper storage location.	___	___	___	___
Average of above evaluations*		___	___	___	___

*This average is the student's final evaluation for competency I3: Align lathe centers using test bar and dial indicator.

MODULE: LATHES

UNIT VII: CUTTING FLUIDS, LATHE CENTER ALIGNMENT AND LATHE GAPS

UNIT TEST

Select the option which best answers the question or completes the statement.

____ 1. Which of the following is not a cutting fluid function?

- a. Raise the workpiece to room temperature
- b. Lubricate the chip-bearing surface of the tool
- c. Obtain better surface finishes
- d. Help in chip removal
- e. Protect the machine and/or equipment

____ 2. What ratios of soluble oil-and-water cutting fluids are most common?

- a. 1:1 and 1:2
- b. 1:5 and 1:10
- c. 1:10 and 1:15
- d. 1:25 and 1:30
- e. 1:30 and 1:40

____ 3. Which types of cutting fluid are used mainly for cooling properties?

- a. Water-soluble and sulfurized-chlorinated oil
- b. Chemically soluble and surfurized oil
- c. Soluble oil and water
- d. Soluble oil and surfurized-chlorinated oil
- e. All of the above

____ 4. Which is not appropriate for use on polyvinyl chloride?

- a. Compressed air
- b. Water
- c. Soap solutions
- d. 100% oil cutting fluids
- e. All of the above

Order the following steps for lathe center alignment.

____ 5. Check alignment.

____ 6. Check concentricity of live center.

____ 7. Fit dead center.

____ 8. Fit live center.

____ 9. Reset tailstock.

____ 10. Set test bar between centers.

a. 1st step
b. 2nd step
c. 3rd step
d. 4th step
e. 5th step
ab. 6th step

ANSWERS TO UNIT TEST

1.	a	(17)
2.	d	(17)
3.	c	(17)
4.	d	(17)
5.	e	(13)
6.	b	(13)
7.	c	(13)
8.	a	(13)
9.	ab	(13)
10.	d	(13)

MODULE: LATHES
UNIT VIII: WORK-HOLDING AND SET-UP

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify work-holding and set-up methods. The student should be able to mount lathe chucks, collet chucks and workpieces between centers. This knowledge will be evidenced by achieving the specified score on the unit test and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms associated with lathes to definitions or illustrations.

1.2 Identify methods used to mount lathe chucks.

1.3 Identify locating, clamping and setting techniques for three-jaw chucks.

1.4 Identify locating, clamping and setting techniques for four-jaw chucks.

1.5 Distinguish methods used to mount collets in the lathe spindle.

1.6 Identify methods used to mount workpieces between centers and onto mandrels. (competency I34)

1.7 Demonstrate the ability to:

   a. Mount lathe chucks. (competency I12, JS 1.1)
   b. Mount collet chucks with draw bar. (competency I12, JS 1.2)
   c. Mount workpiece between centers. (competency I12, JS 1.3)

MODULE: LATHES

UNIT VIII: WORK-HOLDING AND SET-UP

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

  1. Lesson 1: MOUNTING AND CLAMPING WORKPIECES

    a. Information outline

    b. Job sheets

      JS 1.1: Mount lathe chuck
      JS 1.2: Mount collet chucks with drawbar
      JS 1.3: Mount workpiece between centers

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

  1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

  2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

  3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

  4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

  1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.

  2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.

  3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications

    a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.

    b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

    c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.

    d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.

    e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

MODULE: LATHES

UNIT VIII: WORK-HOLDING AND SET-UP

LESSON 1: MOUNTING AND CLAMPING WORKPIECES

I. Terms and definitions

   A. Chuck scroll--threaded portion used to drive and hold chuck jaws

   B. Hub--wheel or plate onto which tooling or workpiece is mounted

   C. Shim--metal strip used to protect the surface of finished diameters when chucking or clamping

   D. Spanner--C-shaped wrench used to mount or remove the tapered-nose lathe chuck

   E. Tooling--any mounting or holding device, such as a chuck

II. Methods of mounting lathe chucks

   A. Threaded-nose type

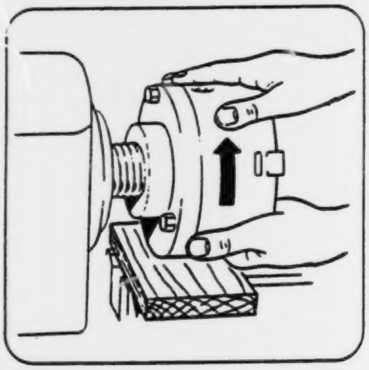
      1. Fitting

         a. Clean spindle thread, location diameter and face.

         b. Clean tooling thread, location diameter and face.

         c. Engage low gear on stopped machine to prevent drive from turning.

         d. Screw tooling to spindle nose using only sufficient force to lock attachment in place.



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      2. Removal

         a. Engage low gear on stopped machine.

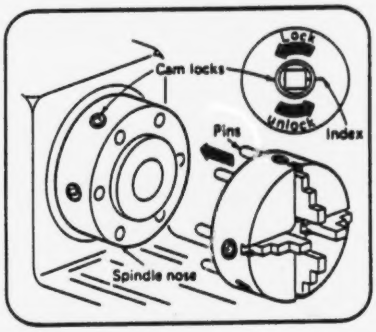
         b. Insert chuck key into chuck.

         c. Hold key in chuck and strike key with heel of hand or soft hammer.

d. Remove chuck and place in storage.

B. Tapered-nose type

C. Cam-lock type



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III. Locating, clamping and setting techniques for three-jaw chuck

A. Changing (removing) jaws

1. Position chuck key and move jaws out until bottom of jaws extend beyond outside diameter of chuck.

2. Grasp No. 3 jaw and lightly pull out while moving jaws out until jaw can be removed from chuck.

3. Repeat for No. 2 jaw, then No. 1 jaw.

B. Engage (replace) jaws

C. Locating and clamping a shaft (three-jaw chuck)

1. To position shaft, open chuck jaws until they are just larger than workpiece's diameter.

2. Position workpiece in chuck with minimum amount extending to allow completion of machining.

3. Hold workpiece in position and tighten chuck jaws, allowing workpiece to locate central and parallel to jaws.

NOTE: Use shims to protect surface of finished diameters.

D. Locating and clamping large diameters

1. To position the workpiece, open the chuck jaws until they are just larger than diameter of workpiece.

2. Visually check that end of vise jaws lies within outside diameter of chuck.

NOTE: If the jaws extend beyond the outside diameter of the chuck, change to stepped jaws and use the lowest step that will bring the jaws within the chuck diameter.

3. Position workpiece in chuck, locating face of workpiece on face of chuck or jaw.
4. To clamp the workpiece, hold it in position and tighten chuck jaws, allowing workpiece to locate central to jaws.
5. Lightly tighten chuck and tap workpiece with soft hammer to seat on chuck face.
6. Tighten jaws securely, being sure to protect the surface of finished diameters.

E. Clamping hexagonal bar

1. Position workpiece in chuck with flats aligned to jaw faces.
2. To clamp the workpiece, hold it in position and tighten jaws until very slight movement of workpiece is felt.
3. Continue to tighten jaws, rocking workpiece with a very slight twisting movement.
4. Feel amount of rock diminish until no movement can be felt.
5. Tighten jaws securely.

F. Clamping in bore of workpiece

1. To position workpiece, open or close jaws, visually comparing setting to bore diameter.
2. Position locating face of workpiece on face of chuck or face of stepped jaws.
3. Ensure that maximum depth of bore possible is engaged on jaw.

   CAUTION: Use the jaw's full length, if possible. Small diameter or shallow bores should be gripped on stepped jaws.

4. To clamp the workpiece, hold it in position and open chuck jaws, allowing workpiece to center up.
5. Tap workpiece to seat face.
6. Tighten chuck, but do not over-tighten because chuck jaw pressure may distort workpiece.

IV. Locating, clamping and setting techniques for four-jaw chuck

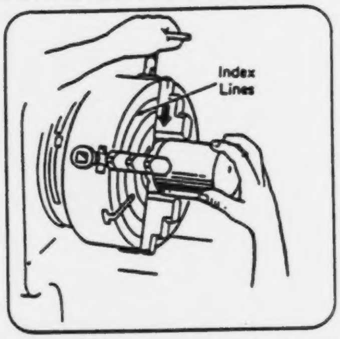
A. Reversing the jaws

1. To remove jaws, position chuck key and move jaw out until bottom of jaw extends beyond diameter of chuck.
2. Grasp jaw and pull out lightly, still moving jaw out until it can be removed from chuck.
3. To engage the jaw, turn chuck jaw end-for-end.
4. Engage jaw into slide of chuck, letting jaw slide freely.
5. Push jaw in until teeth contact adjusting screw.
6. Push jaw in lightly and rotate chuck key to move jaw into rough position to hold work.
7. Repeat for other jaws.

B. Clamping symmetrical workpieces

1. To position chuck jaws, move jaws in or out to approximate size of workpiece.

2. Set jaw to same index line on face of chuck.



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3. Visually measure distance between opposite jaws and adjust each jaw equally to approximate size of workpiece.

4. Position workpiece in chuck with minimum amount extending to allow machining to be completed.

   CAUTION: It will be difficult to set the workpiece concentric if the entire jaw length is used for clamping. To avoid excess overhang of the workpiece, shim strips 3/4" square and 1/8" thick should be inserted between the clamping surface of each jaw and the workpiece.

5. To clamp the workpiece, hold it in position and move opposite jaws in equal amounts until workpiece is lightly clamped. Repeat for the other two jaws.

6. Tighten jaws securely, protecting finished surfaces from damage by inserting shims between the jaws and machined surfaces.

C. Centering regular-shaped workpiece

1. To center the workpiece, start machine spindle.

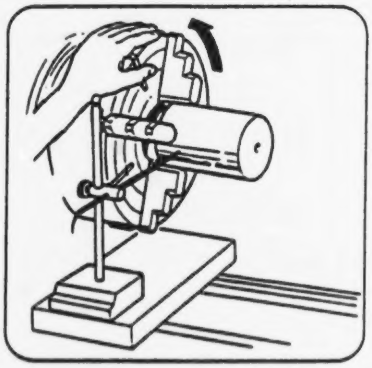
2. Visually check concentricity by comparing workpiece diameter to a fixed part of the machine.

3. Judge whether amount of runout will allow diameter to clean-up.

   NOTE: If the jaws were carefully set to index rings and the rough diameter is well oversized, additional centering may not be necessary.

4. To accurately center workpiece, stand base of surface gage on flat bed of machine.

5. Raise scriber point to approximate centerline of diameter.



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6. Position point of scriber just clear of chuck jaws.

7. Rotate chuck by hand and slide scriber in until point just touches highest point of diameter.

8. Rotate chuck to position widest gap at point of scriber.

9. Loosen nearest jaw half the amount of gap.

10. Tighten opposite jaw to move workpiece over.

11. Repeat checking and adjusting until scriber point touches whole diameter.

NOTE: Hexagons and similar shapes are set in the same way except the scriber is slid in to just touch the highest corner, and each corner is finally lightly touched by adjusting jaws.

D. Checking alignment of workpiece

1. Move the scriber to position point at end of workpiece farthest from chuck.

2. Rotate chuck and move scriber in until point just touches highest point of diameter.

3. Rotate chuck until widest gap is seen between scriber and workpiece.

4. Tap workpiece toward scriber with half the gap width visible.

5. Repeat checking and adjusting until scriber point touches all around workpiece diameter.

NOTE: An alternate method can be used. Hold a pencil or chalk toward revolving workpiece and adjust jaws until centered.

E. Centering irregular-shaped workpiece

1. Irregular-shaped workpieces are usually laid out first to obtain a reference line for centering.

2. Set job approximately centered in chuck.

3. Stand base of surface gage on cross slide.

4. Position point of scriber to almost touch workpiece face.

5. Set point of scriber to center of lathe spindle.

6. Rotate chuck by hand and adjust scriber point to point of reference circle farthest from center.

7. Rotate chuck by hand 180°, observing variation of reference from scriber point.

8. Loosen jaw nearest to scriber point. Distance between marked line and scriber should be divided in half.

9. Tighten opposite jaw securely.

10. Repeat checking and adjusting until scriber point remains aligned to marked line all around workpiece.

11. Tighten jaws securely.

F. Balancing workpieces

1. It may be necessary to counter-balance the workpiece if it is irregularly shaped or is being turned eccentrically.

2. To approximately balance the chuck, disengage spindle gear and allow heavy point on workpiece to rotate to bottom.

3. Judge amount of weight required to counterbalance offset weight of workpiece.

4. Engage bolt in upper T-slot and clamp balancing weight to face of chuck.

5. Tighten balancing weight in position.

6. To check balance, rotate chuck 90° by hand and hold stationary.

7. Release chuck. If correctly balanced, chuck should remain stationary.

8. Note if weight or workpiece rotates to bottom.
    a. Increase amount of balancing weight if workpiece rotates to bottom.
    b. Decrease amount of balancing weight if weight rotates to bottom.

9. If the chuck rotates very slowly, only slight adjustment of weight position is required outward if workpiece rotates to bottom; inward if weight rotates to bottom.

10. Check balance and adjust until chuck stays stationary when stopped in any position.

G. Using a dial indicator to center workpiece

1. Attach dial indicator to stationary part of the machine (usually onto the cross slide or on top of the compound rest).

2. Raise dial indicator to position stylus on workpiece centerline (either vertical or horizontal).

3. Depress stylus to obtain reading on diameter of workpiece as near as possible to check jaws.

4. To center the workpiece, rotate the chuck to see amount of runout error on dial indicator.
5. Zero the dial indicator at half of total error obtained.
6. Rotate chuck to position dial indicator stylus at lowest reading.
7. Loosen chuck jaw at point where lowest reading is obtained.
8. Tighten opposite jaw to move workpiece toward dial indicator and bring indicator to zero.
9. Retighten loosened jaw.
10. Repeat rotating and adjusting procedure until the same reading is obtained all around workpiece.
11. Tighten opposite jaws alternately; apply equal pressure to each jaw when tightening.
12. Recheck setting with dial indicator.
13. To check the workpiece alignment, move the dial indicator to position stylus at end of workpiece farthest from chuck.
14. Rotate chuck to see amount of error on dial indicator.
15. Zero dial indicator at half of error.
16. Rotate chuck until lowest reading is obtained on dial indicator.
17. Tap workpiece toward dial indicator until zero is obtained.
18. Repeat checking and adjusting until same indicator reading is obtained all around workpiece.
19. Recheck close to chuck jaws and at farthest end of workpiece.
20. Repeat checking and adjusting at each end of workpiece until required degree of true rotation is obtained.

V. Collet chucks

- A. Spring collets
    - 1. Spring collet chuck
        - a. Mount collet chuck to spindle nose.
        - b. Insert collet into chuck.
        - c. Insert workpiece into collet.
        - d. Tighten chuck.
    - 2. Draw-in collet attachment
        - a. Set up drawbar attachment.
        - b. Grip workpiece in collet.

c. Tighten drawbar.

B. Rubber-flex or Jacobs collets (same mounting procedure as spring collet chuck)

VI. Mounting workpiece between centers and onto mandrel

A. Between centers

1. Fit driving plate to machine spindle.

2. Fit center into headstock spindle.

   a. Clean taper shank of center.

   b. Clean taper in spindle.

   c. Slide center into spindle bore and engage tapers with sharp push. (A tapered sleeve can also be used on some lathes.)

   d. Start machine spindle at moderate speed.

   e. Visually check that point of center does not run out of center.

3. Fit center in tailstock.

   a. Move spindle in or out until approximately 2" extends from tailstock.

   b. Clean taper in tailstock spindle.

   c. Clean taper shank of center.

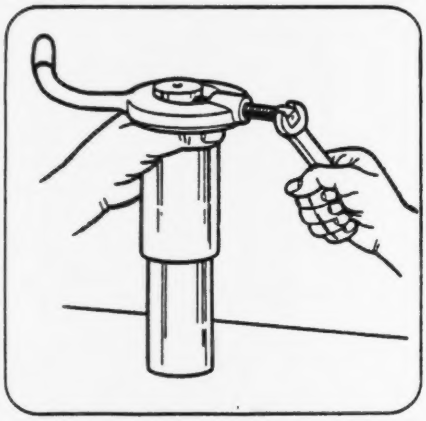
   d. Slide center into tailstock and engage tapers with sharp push.

4. Fit driving dog to workpiece.

   a. Select suitably sized driving dog for workpiece.

   b. Hold workpiece vertical with hand approximately the thickness of dog from end.

   c. Slide dog on workpiece and rest on hand. Be sure tail of drive dog is positioned upward.



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d. Tighten dog securing bolt. If clamping onto a finished diameter, place a soft shim (copper or aluminum) between dog bolt and workpiece.

5. Mount workpiece between centers.

   a. Loosen tailstock clamp.

   b. Slide tailstock to approximate position, visually judging distance between centers to length of workpiece.

   c. Position dog end of workpiece on headstock center.

   d. Hold workpiece in position approximately parallel to machine ways and move saddle to position tool even with end of workpiece.

   e. Slide tailstock up to saddle and clamp in position.

   f. Apply lubrication to dead center position tailstock and center-drilled hole in workpiece or use rolling tail center in tailstock.

   g. Align center hole in workpiece to point of center and move center out to engage in workpiece center hole.

   h. Rotate workpiece back and forth to check that it rotates freely without end play.

   i. Lock tailstock spindle.

B. Mounting workpiece onto mandrels and between centers

1. Preparing to mount the plain-tapered mandrel

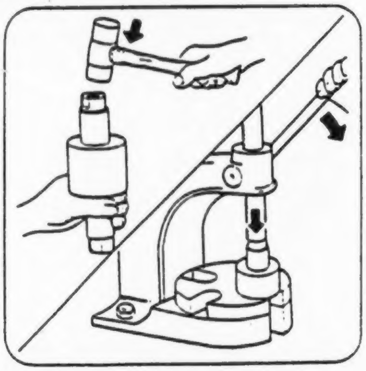
   a. Select mandrel of same size as bore of workpiece.

   b. Clean mandrel and remove burrs.

   c. Clean workpiece bore; remove any burrs or sharp corners.

   d. Measure mandrel to find small end. (Mandrels are usually marked with a plus or minus sign at each end to denote large or small end.)

2. Installing workpiece on mandrel



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a. Insert mandrel into workpiece bore; slide in until tight.

b. Hold workpiece and seat mandrel using a soft hammer or tapping large end of mandrel on wooden floor or block.

NOTE: An alternate method uses a bench press.

c. To remove a workpiece from the mandrel, use the same procedure except that the opposite end of the mandrel is pressed or tapped using soft hammer.

3. Place mandrel between centers. The procedure is exactly the same as engaging a workpiece between centers, except that the cutting pressure must be toward the large end of the mandrel; otherwise, the workpiece can be pushed off the mandrel by the cutting pressure.

JS 1.1

MOUNT LATHE CHUCK

Equipment:

Cam-lock chuck
Wipe cloth
Chuck wrench
Sling, if necessary
Protective board

	Evaluation			
Procedure:	3	2	1	N
1. Clean chuck pins and mating faces.	___	___	___	___
2. Set all cam locks on spindle so that chuck pins can be inserted.	___	___	___	___
3. Sling chuck and swing into position. Be sure protective board is on ways.	___	___	___	___
4. Insert pins into spindle holes.	___	___	___	___
5. Push chuck home and tighten all cam locks securely; note index marks.	___	___	___	___
6. Rotate chuck by hand to recheck.	___	___	___	___
7. Return equipment to its proper storage area.	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's partial evaluation for competency I12: Center workpiece in four-jaw chuck.

JS 1.2

MOUNT COLLET CHUCKS WITH DRAWBAR

Equipment:

Wipe cloth
Collet taper
Drawbar
Soft hammer
1/2" collet
1/2" bar stock
Single-cut file
3/4" length knockout rod

Procedure:	Evaluation 3	2	1	N
1. Set up drawbar attachment. Clean spindle nose, collet taper and drawbar. Push collet taper into spindle bore. Insert drawbar into spindle of lathe.	_	_	_	_
2. Insert collet. Select appropriately sized collet and clean inside and outside, including threads. Insert collet into taper while aligning keyway in collet with key extending into housing bore. Hold collet in position and turn drawbar until collet thread engages with drawbar thread.	_	_	_	_
3. Grip workpiece in collet. Clean and deburr workpiece; check that diameter of collet bore is same as diameter of workpiece. Insert workpiece in collet, tightening until strong resistance is felt.	_	_	_	_
4. Remove workpiece from collet. Release drawbar and remove workpiece using a sharp tap on drawbar end with a soft hammer.	_	_	_	_
5. Remove collet. Unscrew drawbar and give it a sharp tap with soft hammer to loosen collet. Remove drawbar and collet.	_	_	_	_
6. Remove collet taper. Select knockout rod; push rod down spindle (brass end first) until contact is made with taper. Do not let taper fall out of spindle taper onto ways.	_	_	_	_
7. Return equipment to its proper storage location.	_	_	_	_
Average of above evaluations*	_	_	_	_

*This average is the student's partial evaluation for competency I12: Center workpiece in four-jaw chuck.

JS 1.3

MOUNT WORKPIECE BETWEEN CENTERS

Equipment:

Drive plate
Lathe center
Taper sleeve
Drive dog, 1"
Revolving tailstock center
Wipe cloth
Oilstone
Workpiece, 1" diameter
Wrench

	Evaluation			
Procedure:	3	2	1	N
1. Fit driving plate to machine spindle.	___	___	___	___
2. Fit center into headstock spindle.	___	___	___	___
3. Fit rotating center in tailstock.	___	___	___	___
4. Fit driving dog to workpiece.	___	___	___	___
5. Mount workpiece between centers.	___	___	___	___
6. Rotate workpiece back and forth to check that it rotates freely without end play.	___	___	___	___
7. Return all equipment to its proper storage location.	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's partial evaluation for competency I12: Center workpiece in jour-jaw chuck.

MODULE: LATHES

UNIT VIII: WORK-HOLDING AND SET-UP

UNIT TEST

Match the following definitions with the appropriate terms.

____ 1. Wheel or plate onto which tooling or workpiece is to be mounted

____ 2. Any mounting or holding device, such as a chuck

____ 3. Threaded portion used to drive and hold chuck jaws

____ 4. Used to protect the surface of finished diameters when chucking or clamping

____ 5. C-shaped wrench used to mount or remove a tapered-nose type lathe chuck

a. Chuck scroll

b. Drawbar

c. Hub

d. Shim

e. Spanner

ab. Tooling

Select the option which best answers the question or completes the statement.

____ 6. Which of the following is not a type of lathe chuck mounting?

a. Flange
b. Threaded-nose
c. Tapered-nose
d. Cam-lock
e. All of the above

____ 7. When removing jaws on a three-jaw chuck, which jaw will become free first?

a. No. 1
b. No. 2
c. No. 3
d. All are freed simultaneously.
e. Jaws are never removed.

____ 8. What device can be placed between jaws and workpiece to protect the workpiece from marks?

a. Rubber strip
b. Paper towel
c. Mandrel
d. Shims
e. Gibs

____ 9. When centering symmetrical workpieces in the four-jaw chuck, set the jaws equally according to the __________ .

a. Index lines
b. Matrix lines
c. Appendix lines
d. Graduated dial
e. Cross-feed dials

____ 10. Which tooling device can be used to accurately center the workpiece in the four-jaw chuck?

a. Chalk method
b. Carriage stop
c. Micrometer center
d. Profile meter gage
e. Surface gage with scriber

____ 11. When a heavy workpiece is mounted off center in the four-jaw chuck, what is necessary to balance the chuck?

a. Scale
b. Mandrel weight
c. Micrometer center
d. Counter balance
e. Carriage balance

____ 12. To detect the total amount of error when centering a workpiece in a four-jaw chuck, what device is used?

a. Surface gage with scriber
b. Micrometer
c. Dial indicator
d. Scale
e. Offset gage

____ 13. Which is true of turning a workpiece on a mandrel?

a. Cutting pressure is away from the large end of the mandrel
b. Cutting pressure is toward the large end of the mandrel
c. More cutting pressure is applied
d. Less cutting pressure is applied
e. None of the above

____ 14. Which of the following is not a method for mounting work in the lathe?

a. Between centers
b. Collets
c. Three-jaw chuck
d. Spindle nose
e. Four-jaw chuck

ANSWERS TO UNIT TEST

1.	c	(I12)
2.	ab	
3.	a	(I12)
4.	d	(I12)
5.	e	(I12)
6.	a	(I12)
7.	c	
8.	d	(I12)
9.	a	(I12)
10.	e	(I12)
11.	d	(I12)
12.	c	(I12)
13.	b	(I12)
14.	d	(I34)

MODULE: LATHES

UNIT IX: TOOL-HOLDING SET-UP AND OPERATION

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify major types of tool-holding and set-up techniques. The student should also be able to set-up and machine workpieces according to print specifications. This knowledge will be evidenced by achieving specified scores on the job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms associated with tool-holding set-ups and operations with definitions or illustrations.

1.2 Identify three major types of tool-holding and set-up techniques.

1.3 Identify common turning operation set-up techniques. (competency I10)

2.1 Face workpiece. (competency I9, JS 2.1)

2.2 Turn workpiece between centers. (competency I11, JS 2.2)

2.3 Center drill and counterbore holes. (competencies I9 and I17, JS 2.1 and 2.6)

2.4 Center workpiece in four-jaw chuck. (competency I12, JS 2.3)

2.5 Drill holes. (competency I13, JS 2.4)

2.6 Ream holes. (competency I14, JS 2.4)

2.7 Bore holes. (competency I15, JS 2.5)

2.8 Knurl parts. (competency (I18, JS 2.7)

2.9 Demonstrate the ability to countersink holes. (competency I16, JS 2.6)

MODULE: LATHES

UNIT IX: TOOL-HOLDING SET-UP AND OPERATION

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: SET-UPS

   a. Information outline

   b. Assignment sheet

   AS 1.1: Set-up techniques

   c. Answers to assignment sheet

2. Lesson 2: OPERATIONS

   a. Information outline

   b. Job sheets

   JS 2.1: Face workpiece and center drill
   JS 2.2: Turn workpiece between centers
   JS 2.3: Center workpiece in four-jaw chuck
   JS 2.4: Drill and ream holes
   JS 2.5: Bore holes
   JS 2.6: Countersink and counterbore holes
   JS 2.7: Knurl parts

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.
2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.
3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested supplemental materials

1. Publications
   a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.
   b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.
   c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.
   d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.
   e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.
2. Audiovisuals available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610
   a. Grinding a Lathe Tool Bit (MS-84-341) (video). Sedalia, MO: State Fair Community College, 1984.
   b. Use of the Four-Jaw Independent Chuck, Part I: Semi-Precision Method (MS-86-353) (video). Sedalia, MO: State Fair Community College, 1986.
   c. Use of the Four-Jaw Independent Chuck, Part II: Precision Method (MS-86-354) (video). Sedalia, MO: State Fair Community College, 1986.

MODULE: LATHES

UNIT IX: TOOL-HOLDING SET-UP AND OPERATION

LESSON 1: SET-UPS

I. Terms and definitions

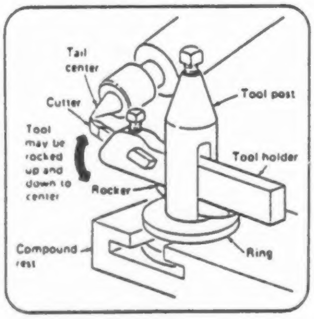
- A. Build up--to position tooling for facing; the use of gage blocks or end setting bar which is held onto the face of shoulder
- B. Facing off--turning face of workpiece to center or bore
- C. Plugs--accurately ground measuring devices used to determine size of bored or reamed holes
- D. Quick change--a cam-locked, tool-holding accessory which is locked onto the master holder
- E. Rocker--crescent-shaped accessory that permits the tool and tool holder to be adjusted up and down when placed onto setting ring
- F. Turret--holding device which permits four tools to be mounted at the same time; each tool can be rotated into machining position

II. Three major types of tool-holding and set-up

- A. Setting ring and rocker tool holders

  NOTE: The rocker under the tool holder permits up-and-down adjustment to help position the cutter at center height.

  1. Place ground tool in holder; clamp with minimal overhang.
  2. Place tool holder through post and on top of rocker.
  3. Swing cutter tip around so that bit can be matched to tailstock center height. (A line on the tailstock spindle nose can help with this alignment.)
  4. Rock tool holder until cutter tip is in line with tail center. Clamp lightly and recheck position.



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  5. If center height holds, swing tool holder back to machining position.

6. Tighten tool post clamp securely.

B. Quick-change tool holders

NOTE: In the quick-change system, the holder is cam-locked onto the master holder. Center height is set by a thumb wheel on set screw.

1. Position the master holder on the compound rest.

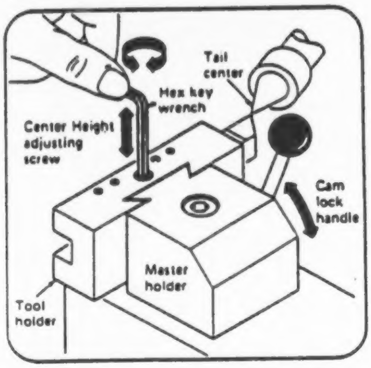
2. Place a properly ground cutter into a selected bar.

3. Place the bar onto the master holder dovetail slide.

4. Swing the master holder around until the tool bar with cutter is positioned near the tail center.

5. Lock the master holder down and release the cam lock to permit adjustment of the tool holder height.

6. Use the thumb wheel or set screw to adjust the cutter holder to center height position.



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7. When adjustment is complete, lock the cam and recheck the center height position.

   NOTE: Always check tool height position with the master holder cam in locked position.

8. If positioned correctly, swing the master holder back to machined position.

C. Turret tool holders

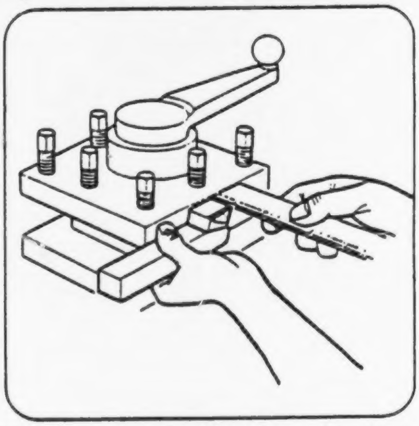
NOTE: The turret tool post permits four tools to be mounted simultaneously; each tool can then be rotated into machining position.

1. Select appropriate tool; check that it is correctly ground.

2. Check height-to-tool point.

   a. Hold bottom face of tool shank on a flat face.

b. Measure height of tool to cutting edge.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 108. Reprinted by permission of John Wiley & Sons, Inc.

c. Adjust height by inserting shims under tool until correct measurement is obtained.

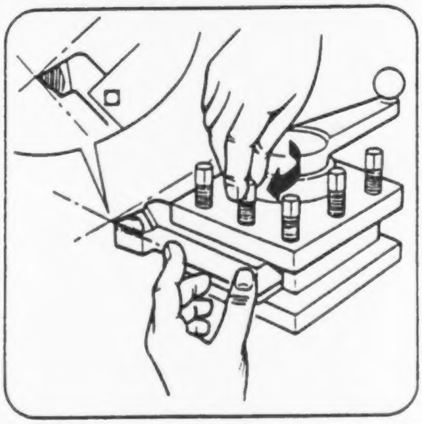
3. Position and clamp tool in tool post.

   a. Clean bottom face of tool post.

   b. Place shims in appropriate station of tool post, visually checking that they are positioned up to front edge and under both securing screws.

   c. Place tool on shims with cutting edge toward workpiece and with minimum amount of tool overhang.

   d. Push tool shank up to side of tool post; check clearance angles by visually relating them to a fixed machine part.



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   e. Push front of tool to left or right to adjust clearance as required.

   f. Visually check that tool shank is under both securing screws and that neither rear of tool nor shims extend over next tool station.

   g. Hold tool in position; finger-tighten securing screws.

        h. Tighten securing screws firmly with appropriate wrench.

III. Common turning operation set-up techniques

    A. Facing off (turning face to center or bore)

    B. Turning a diameter to a shoulder

    C. Center drilling

    D. Turning a diameter between centers

    E. Drilling holes

    F. Flat-bottom hole drilling

    G. Reaming holes

    H. Using taper reamers

    I. Boring holes

    J. Knurling

AS 1.1

SET-UP TECHNIQUES

Match the following terms and definitions.

____ 1. Holding device which permits four tools to be mounted at the same time; each tool can be rotated into machining position

____ 2. Accurately ground measuring devices used to determine size of bored or reamed holes

____ 3. Crescent-shaped accessory that permits the tool and tool holder to be adjusted up and down when placed onto setting ring

____ 4. Cam-locked, tool-holding accessory which is locked onto the master holder

____ 5. To position tooling for facing; the use of gage blocks or end setting bar which is held onto the face of shoulder

____ 6. Turning face of workpiece to center or bore

a. Build up
b. Facing off
c. Parallelism
d. Plugs
e. Quick change
ab. Rocker
ac. Turret

7. List two of the three major types of tool-holders.

a.

b.

8. List four common turning operation set-up techniques.

a.

b.

c.

d.

ANSWERS TO AS 1.1 (I10)

1. ac

2. d

3. ab

4. e

5. a

6. b

7. Two of the following:
   Setting ring and rocker tool holders
   Quick-change tool holders
   Turret tool holders

8. Four of the following:
   Facing off (turning face to center or bore)
   Turning a diameter to a shoulder
   Center drilling
   Turning a diameter between centers
   Drilling holes
   Flat-bottom hole drilling
   Reaming holes
   Using taper reamers
   Boring holes
   Knurling

MODULE: LATHES

UNIT IX: TOOL-HOLDING SET-UP AND OPERATION

LESSON 2: OPERATIONS

I. Steps for facing off (turning face to center or bore)

A. Preparation

1. Set workpiece using appropriate work-holding method; true up.

2. Set facing tool in tool post.

3. Set speed and feed.

B. Touching tool to face

1. Using carriage and cross slide, position cutting point of tool just clear of face to be machined.

2. Start machine spindle.

3. Move saddle to carry tool toward the face of workpiece. Control approach by watching decreasing gap between tool and face. Stop carriage movement when tool lightly contacts face.

4. Using cross slide, clear tool from face.

5. Clamp saddle to lathe ways.

C. Machine face

1. Zero dial on compound slide.

2. Make required cut using compound slide.

3. Turn on coolant.

4. Using cross slide, hand-feed tool across face of workpiece. Maintain even feed rate.

5. When cutting point clears center of bar, withdraw cross slide and make additional cuts until face is cleaned up.

NOTE: Automatic cross-feed can be used.

6. Stop machine spindle; turn off coolant, check face for finish and flatness.

7. Determine whether tool setting is correct.

NOTE: When a large amount is to be removed from the face, take rough cuts and leave approximately .030" for finish machining.

D. Facing to length from shoulder

1. Rough turn face to leave about 1/32" on required length.

2. Check length using appropriate measuring instrument.

3. Set finish cut using compound slide.

4. Face to length.

5. Remove sharp edges.

NOTE: An end bar or build-up of gage blocks can be held onto the face of shoulder to position tooling for facing.

E. Facing overall length

1. To machine first face, check length of workpiece, noting amount of metal to be removed.

2. Set workpiece in center using appropriate work-holding device.

3. Rough and finish-turn face of workpiece, removing approximately half the excess length of metal.

4. Remove sharp edges.

5. Remove workpiece from machine.

6. To machine second face, check length.

7. Reset workpiece to machine opposite face.

8. Touch tool to face.

9. Set depth of cut on compound slide index.

10. Rough turn face.

11. Measure length of workpiece; if the rear end of the workpiece is accessible, the length can be checked without removing workpiece from the machine.

12. Finish turning face. If facing the end(s) of a shaft located on center, a half-center should be engaged in the tailstock.

13. Remove sharp edges.

14. Remove workpiece and check length.

II. Turning a diameter to a shoulder

A. Preparation

1. Set workpiece true in chuck.

2. Set facing and turning tools in tool post.

3. Set speed and feed to suit material and required finish.

B. Position facing tool to front station.

C. Machine face.

D. Touch tool to workpiece diameter.

   1. Position turning tool to front station.
   2. Move cross-slide to position point of tool clear of workpiece diameter.
   3. Unlock carriage and move along to position tool just within length of workpiece.
   4. Start machine spindle.
   5. Move cross slide in, controlling feed rate by watching decreasing gap between tool and workpiece until tool cuts a very fine line on diameter.
   6. Zero cross slide index.

E. Rough turn diameter and length.

   1. Move tool clear of workpiece end.
   2. Determine amount of metal to be removed to leave approximately .015" on diameter for finish machining.
   3. Using cross slide index, apply cut.

      NOTE: The cut's depth will depend on the amount of metal to be removed. If substantial, several roughing cuts can be taken.

   4. Move carriage so tool almost touches end of workpiece.
   5. Engage feed.
   6. Control machining length by holding rule against shoulder; disengage feed when approximately .030" from required length.
   7. Move carriage back to original starting position. Apply further roughing cuts as necessary to bring diameter within .015" of finished size.

F. Finish turn diameter and shoulder.

   1. Move tool clear of workpiece end.
   2. Set finishing cut on cross-slide index.
   3. Engage feed.
   4. When cut is approximately 1/8" along workpiece diameter, disengage feed and stop machine.
   5. Check diameter and adjust depth of cut, if required.
   6. Engage feed and take cut.
   7. As tool approaches shoulder, disengage feed.
   8. Hand-feed carriage to touch tool to shoulder.

        9. Hand-feed tool out across face of shoulder, maintaining an even feed rate.

    G. Face shoulder to length.

        1. Using appropriate measuring instrument, check length from end face to shoulder.

        2. Using cross-slide, set cut required.

        3. Move cross slide in, maintaining even feed rate.

        4. Decrease feed rate as tool nears diameter and watch for facing cut to blend in.

        5. Move tool out to clear workpiece.

        6. Check length.

        7. Take additional cut(s) if required.

    H. Remove sharp edges and inspect workpiece.

III. Center drilling

    A. Preparation

        1. Face off end of workpiece.

        2. Insert drill chuck in tailstock sleeve.

    B. Insert center drill in chuck.

        1. Select correct sized center drill.

        2. Position center drill in chuck with necessary amount extending kept to a minimum.

        3. Tighten chuck securely with correct chuck key.

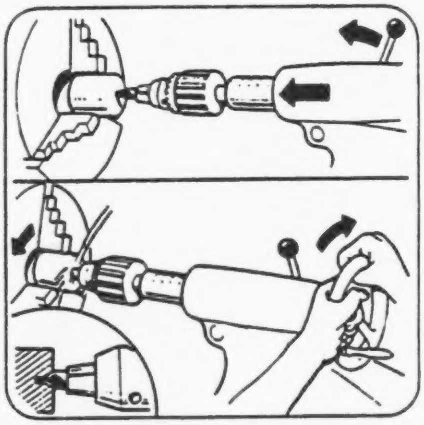
    C. Center drill workpiece face.

        1. Slide tailstock to position with point of center drill close to workpiece face.

        2. Clamp tailstock in position.

        3. Set speed and start machine spindle.

4. Advance tailstock spindle to touch point of center drill to workpiece.



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5. Apply coolant.

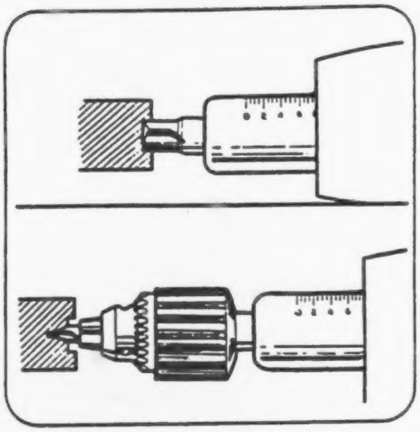
6. Carefully advance center drill into workpiece face to full depth of chamfer without producing a hole.

   NOTE: Chips tend to build up in the flutes of small center drills, so withdraw drill frequently and clean flutes.

7. Withdraw center drill and tailstock when depth is reached.

D. To produce protected center drilling, counterbore.

1. Select end mill or bottom drill of same diameter as recess.
2. Engage bottom drill in tailstock.
3. Slide tailstock to position drill face close to workpiece face.
4. Clamp tailstock in position.
5. Start machine spindle; advance tailstock sleeve to touch drill face to workpiece face.



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6. Measure length of sleeve extending or note reading of index on tailstock spindle or handwheel.

7. Advance drill into workpiece, measuring length of spindle extending until correct depth is obtained.

8. Withdraw drill and clear tailstock.

E. Center drill bottom face of recess.

IV. Turning a diameter between centers

A. Preparation

1. Set workpiece between centers.

2. Set turning tool in tool post.

3. Set speed and feed to suit material on surface requirement.

B. Set length of cut.

1. Rotate drive plate by hand.

2. Move carriage to position tool and tool post just clear of dog.

3. Start spindle and touch tool to diameter to mark length of cut.

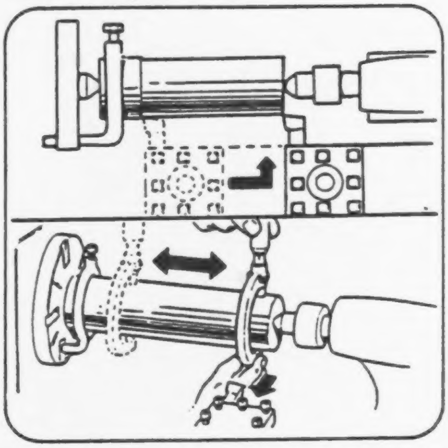
4. Move tool clear of workpiece.

C. Check parallelism.

1. Touch tool to diameter at tailstock end of workpiece.

2. Set light cut to clean up diameter.

3. Traverse cut to marked length.



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4. Measure diameter at each end to check parallelism.

5. Adjust tailstock if taper is found.

6. Take additional light cut(s); check until diameter is parallel.

7. Note size of workpiece.

D. Turn diameter.

1. Calculate amount of metal to be removed.

2. Rough turn diameter to marked length, leaving approximately .015" for finish cut.

3. Set for finish cut on cross-slide index. Decrease feed rate.

4. Take cut approximately 1/8" along workpiece.

5. Check diameter.

6. Adjust depth of cut if necessary.

7. Finish turn diameter.

E. Turn opposite end of workpiece.

1. Reverse workpiece between centers.

   NOTE: Protect the finished diameter from damage by using a shim under the dog screw.

2. Rough turn diameter, allowing tool to just clear shoulder and leaving .015" for finishing cut.

3. Move tool in until a very small gap can be seen between tool point and finished diameter of workpiece.

4. Traverse cut to just clear end face.

5. Move saddle to position tool in front of finished turned diameter.

6. Move tool in until no gap can be seen between tool point and workpiece. Do not mark diameter with tool point.

7. Traverse cut to just clear end face.

8. Check diameter for size.

9. Blend in joints of cut.

V. Drilling holes

A. Mount workpiece.

1. Clean chuck jaws.

2. Mount workpiece in chuck.

3. True up if required.

4. Tighten the chuck.

5. Recheck for concentricity.

B. Face end and rough turn workpiece.

C. Center drill workpiece.

D. Mount drill in tailstock.

CAUTION: Hold the drill on the non-tapered diameter when mounting.

1. Select required drill.

2. Mount drill in tailstock, using taper sleeves as necessary. A drill chuck can also be used to hold drill.

3. Retract tailstock spindle as far as possible without ejecting drill.

E. Position tailstock to workpiece.

1. Loosen tailstock on machine ways.

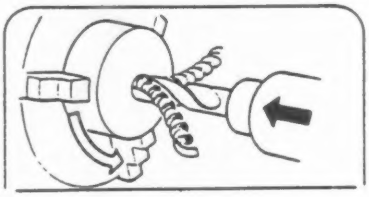
2. Slide forward to almost touch drill point to workpiece.

3. Tighten tailstock to ways.

F. Drill hole through workpiece.

1. Apply firm, even pressure to tailstock handwheel to feed drill into workpiece.

2. Feed in gently until drill is cutting its full diameter.



3. Apply coolant.

4. Relieve handwheel pressure frequently to break up chips. (If hole depth is deep, release tailstock and slide out of hole to release chips, then resume drilling.)

   NOTE: If the drill has been ground correctly and is cutting efficiently, some metal chips will emerge from the drill flutes as two equal helices.

5. Just before break-through a drop in resistance-to-feed will be felt. Immediately ease pressure on the handwheel to allow a cleaner break-through and to minimize drill damage.

6. Ease drill fully through.

G. Drill hole to depth.

1. Apply firm, even pressure to tailstock handwheel to feed drill into center-drilled workpiece.

2. Stop feed as drill begins to cut full diameter.

3. Note setting on tailstock sleeve or measured length of sleeve extending from tailstock.

4. Add depth of hole required to reading obtained.

5. Drill hole. Note setting or scale reading for required depth.

H. Flat-bottom hole drilling

1. Center drill workpiece.

2. Drill to depth.

   a. Select standard drill of correct size.

   b. Insert drill in tailstock.

   c. Set tailstock to position drill point near workpiece face.

   d. Move drill out until point is aligned to workpiece face.

   e. Note reading on tailstock spindle, apply coolant and drill to required depth minus approximately 1/16".

3. Drill using flat-bottom drill.

   a. Select correct sized flat-bottom drill; insert into tailstock.

   b. Set tailstock to position drill face approximately 1/8" clear of workpiece face.

   c. Hold a thin parallel strip to workpiece face across hole.

   d. Slide parallel strip back and forth and move in drill until strip lightly resists.

   e. Note reading on tailstock scale.

   f. Remove strip, turn on coolant and drill to depth plus thickness of parallel strip.

   g. Reduce feed rate when approaching required depth.

   h. Withdraw drill when required depth on scale is reached; check depth.

VI. Reaming holes

A. Center drill.

B. Drill for reaming procedure.

1. Select drill 1/64" smaller than finished hole size.

2. Drill hole through or to depth as required.

NOTE: The drilling depth should be approximately 1/16" more than the finished depth of the reamed hole unless the depth is specifically stated on the drawing.

C. Ream to check size.

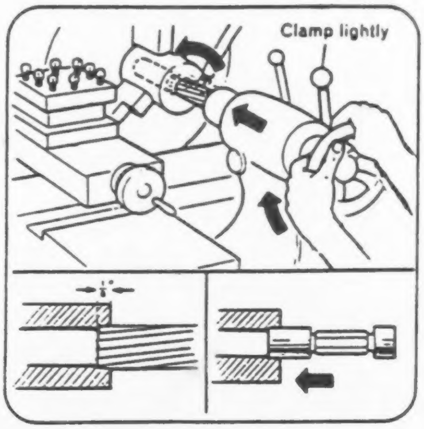
1. Set spindle speed at about half the drilling speed.

2. Slide tailstock to position end of reamer approximately 1/8" clear of the workpiece face.

3. Lightly clamp tailstock.

4. Start machine spindle.

5. Apply coolant and feed reamer approximately 1/8" into workpiece, maintaining even feed rate.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 123. Reprinted by permission of John Wiley & Sons, Inc.

6. Withdraw reamer from workpiece.

7. Stop spindle and check size of bore. (Ground plugs are normally used to determine size.)

8. Follow general rules.

   a. A reamer will cut slightly larger if rpm or feed is increased or coolant is not used.

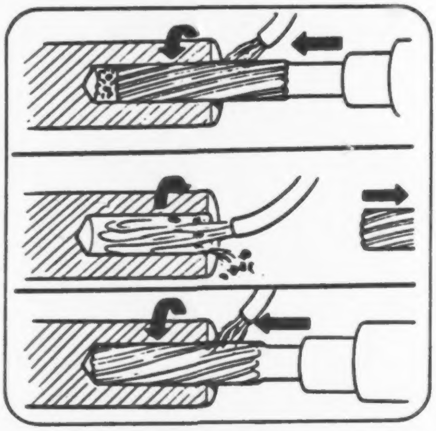
   b. A reamer will cut slightly smaller if rpm or feed is decreased or oil is used instead of coolant.

D. Ream to depth.

1. Reset tailstock to original position and lightly clamp.

2. Apply coolant and feed reamer into workpiece.

3. Maintain light pressure to obtain even reamer cutting action.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 124. Reprinted by permission of John Wiley & Sons, Inc.

4. Move reamer out of workpiece when resistance to turn the handwheel builds up.

5. Reverse machine spindle and direct coolant into bore. This will wash out a majority of chips trapped at the bore's bottom.

   NOTE: Don't reverse spindle with reamer in contact with the work.

6. Return spindle to forward rotation.

7. Move reamer into workpiece.

8. Move reamer out when resistance builds up again at bottom of bore.

E. Ream through.

NOTE: The procedure is exactly the same as reaming to depth except that feed rate is reduced as pressure eases when reamer is breaking through end of workpiece.

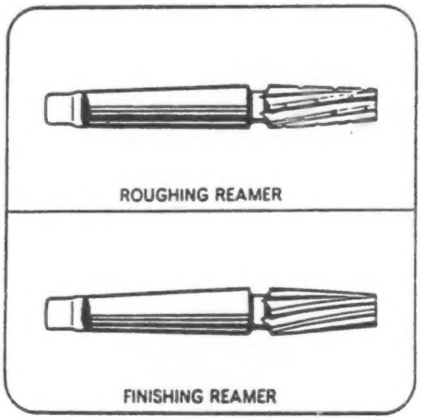
F. Use taper reamers.

1. Prepare workpiece.

a. Face off.

b. Center drill.

c. Drill slightly smaller than the smallest diameter of finished taper.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 126. Reprinted by permission of John Wiley & Sons, Inc.

NOTE: The surface finish and accuracy of tapered bores produced by reaming are generally better than those produced by conventional boring. Tapered reamers for standard tapers are usually supplied in pairs of a roughing and a finishing reamer.

2. Ream to allow finishing cut.

a. Set roughing reamer in tailstock.

b. Select slow speed. (Consult the Machinery's Handbook.)

c. Position tailstock and lock.

d. Start machine spindle.

e. Advance reamer slowly, using abundant cutting lubricant.

f. Withdraw reamer occasionally to clear chips with brush.

g. Continue reaming and do not stop feeding during cut.

h. Check depth of taper.

3. Using finishing reamer, repeat above operations.

VII. Boring holes

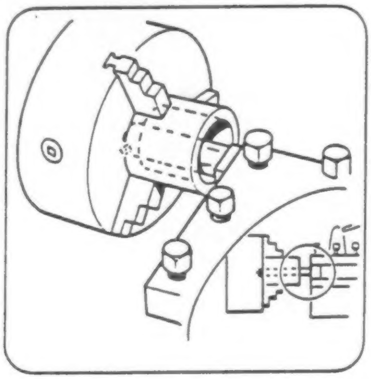
A. Drill through

1. Select drill approximately 1/16" smaller than finished size.

2. Drill through. (If the bore is very large, use the biggest drill available.)

B. Set boring bar.

1. Select boring bar or tool long enough to cover bore depth and give about 1" clearance between workpiece face and tool post.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 127. Reprinted by permission of John Wiley & Sons, Inc.

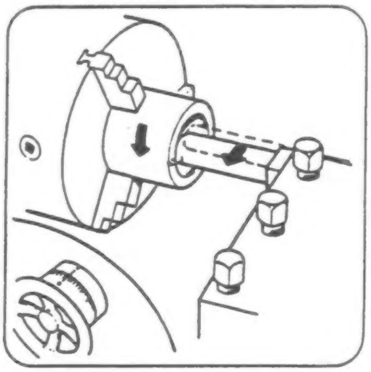
2. Use largest diameter bar possible to increase stability and cut down vibration.

3. Set tool at center height and check to see that tool has sufficient relief to clear inside diameter.

C. Touch tool to bore diameter.

1. Position point of tool just within bore.

2. Move cross slide out until tool contacts bore diameter.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 128. Reprinted by permission of John Wiley & Sons, Inc.

3. Move carriage so that tool just clears workpiece face.

4. Zero cross-slide index.

D. Take roughing cut(s).

1. Select correct feed and speed.
2. Determine amount of material to be removed.
3. Set cut to leave about .010" in bore for finish machining.
4. Apply coolant and engage carriage feed.
5. If cutting action is correct, clean, bright curls of chips will be removed and an even cutting sound will be heard.

   NOTE: If a large amount of metal is to be removed, several roughing cuts can be taken.

6. Check bore size with calipers when full cut is approximately 1/32" in from face.
7. As tool clears rear end of bore, disengage feed.
8. Move carriage to clear tool from bore.
9. Stop spindle and check bore diameter.

E. Take trial cut.

1. Calculate cross-slide index movement required to bore to size.
2. Move tool out to .005" less than required calculation. This allows for tool deflection during the roughing cut.
3. Start spindle.
4. Move carriage to almost touch tool to workpiece face; engage feed.
5. When tool is approximately 1/8" along bore, disengage feed.
6. Stop spindle and move tool out of bore quickly before chuck stops rotating. This action will save tool tip and protect internal bore finish.
7. Check diameter of 1/8" deep cut.
8. Start spindle if bore size is correct.
9. Engage carriage and feed cut through.
10. Disengage feed at end of cut.
11. Note index reading on cross-slide.
12. Move tool in toward bore center to clear wall of bore.
13. Move carriage to clear tool from bore.
14. Check full length of bore diameter.

F. Boring to depth

1. Drill a flat-bottom hole (blind hole) using drill 1/16" smaller than finished diameter of bore.

2. Drill to depth minus approximately .010".

3. Set boring tool by selecting bar or tool long enough to cover full depth of bore.

4. Ensure that tool point extends beyond end of bar.

5. Touch tool to bore diameter.

6. Take trial cut.

7. To rough cut bore to depth, measure from tool point and mark ways with grease pencil or mark line on bar at required depth.

8. Apply coolant and feed cut into bore.

9. Disengage feed as marked line approaches face of workpiece or carriage meets line on slide.

10. Feed in by hand until sound of increased cut is heard.

11. To take finish cut to depth, note final cross-slide index reading at finished size of bore.

12. To face the bottom of the bore to depth, check depth to face and calculate amount to be removed.

13. Move tool clear of wall of bore.

14. Move carriage until marked line on bar or slide is almost aligned to workpiece face or carriage.

15. Advance tool using carriage until sound of tool touching face is heard.

16. Set depth of cut required on compound. If a large amount of material is to be removed, take several cuts.

17. Move tool cut to finished size of bore.

18. Advance same cut toward workpiece center until cutting sound ceases.

VIII. Knurling

A. Set workpiece.

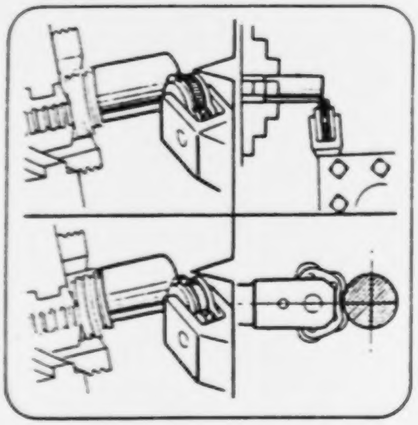
1. Set workpiece with minimum length extending from chuck for this operation.

2. Support long workpieces with a non-rotating center so that set-up is as rigid as possible.

3. Turn diameter to be knurled approximately .010" below finish size required.

B. Set knurling tool.

1. Visually check that knurling tool is free of chips. Clean tool with wire brush if necessary.
2. Set pivot pin to central height.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 144. Reprinted by permission of John Wiley & Sons, Inc.

3. Visually set knurling tool at a very slight angle to give lead-in, if necessary.
4. Tighten tool securely.

C. Knurl workpiece.

1. Set for slow speed and fast feed.
2. Start machine and apply a good flow of coolant.
3. Move knurling tool into workpiece, applying cross-slide pressure until full diamond pattern is formed.
4. Engage feed lever and feed along until required length of knurling is obtained.
5. Move knurling tool off workpiece with a rapid motion.

D. Chamfer corners to remove burrs from end face(s). Set lathe tool; cut a 45° chamfer to bottom of knurled depth.

FACE WORKPIECE AND CENTER DRILL

Equipment:

Right-hand facing tool
Lathe with chuck and tailstock center
Steel rule, 6"
Toolholder
Wrenches for chuck and toolholder
Steel bar, SAE 1018, 2 1/2" diameter, 4 1/4" long
Cutting oil
Quick-change tool post

NOTE: There are many types of tool posts and holders available. Modify procedures slightly depending on the type used.

Procedure: Evaluation 3 2 1 N

1. Check oil levels and perform daily maintenance. ___ ___ ___ ___

2. Chuck workpiece with 2" protruding past end of jaw. ___ ___ ___ ___

   NOTE: For a facing operation, an unsupported workpiece should never extend out of the chuck more than three times its diameter.

3. Loosen the compound's rest locking screws and turn compound 30° to the right of cross-feed; tighten locking screws. ___ ___ ___ ___

   NOTE: The protractor base of the compound rest may or may not read 30°, depending on the zero mark location of the protractor.

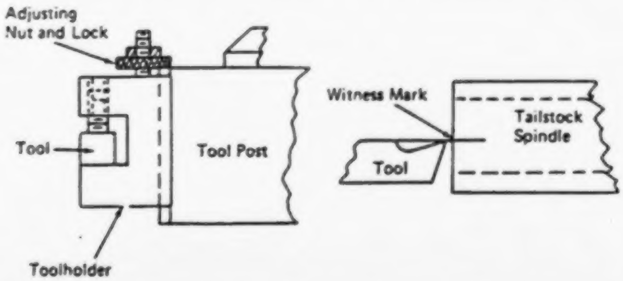
4. Mount tool post on compound. Put tool in toolholder and mount on tool post. ___ ___ ___ ___

   NOTE: The tool should never extend past the end of toolholder more than two times its width.

5. Adjust tool to center height using one of the following methods. ___ ___ ___ ___

   a. Adjust tool up or down with adjusting nut until point of tool is on witness mark on tailstock.

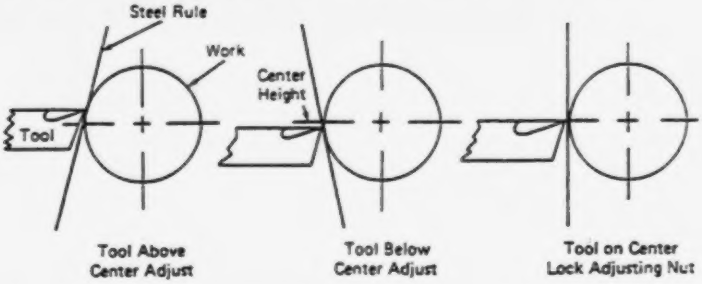
      NOTE: When adjusting toolholder, the cam lock of the tool post must be loosened.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 315.

b. Insert center in tailstock and set point of tool on point of center by adjusting as before.

c. Place 6" steel rule between point of tool and workpiece; advance tool with cross-feed until it holds rule in place; adjust until rule is square to tool or until rule is straight up and down.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 316.

6. Set lathe at correct speed. _ _ _ _

$$\frac{4 \times CS}{\text{Diameter (D)}} = \text{rpm} \qquad \frac{4 \times 120}{2.5} = 192 \text{ rpm}$$

7. Set tool so that cutting edge has about 10° clearance between end of workpiece and tool. _ _ _ _

8. Check setup to make sure chuck, workpiece, tool post and holder, tool and compound are tight; snug carriage lock bolt to prevent carriage from moving. Position tool near outer edge of workpiece. _ _ _ _

9. Turn on lathe, start spindle and advance tool with compound until it starts to cut. Crank the tool away from workpiece with cross-feed until tool clears workpiece 1/8". _ _ _ _

10. Advance compound to cut end of workpiece 0.020"; apply cutting oil as required during cutting. _ _ _ _

NOTE: This movement would be 0.040" if the graduated collar reads 1:1; this type of graduation is also called an **indirect-reading dial** or a **single-depth reading dial.** (The cut is only half the amount of feed is because the compound is set on 30° and the sine of 30° is 0.5.)

11. Crank cross-feed handwheel slowly with a continuous motion until tool reaches center; crank tool back 1/8" from edge of workpiece and stop spindle. _ _ _ _

12. Inspect workpiece. _ _ _ _

    a. If all of saw cut has not been removed, advance compound feed 0.020" and repeat facing procedure.

    b. If a protrusion is left in the center, the tool height is incorrect; adjust tool height and repeat facing procedure.

    c. Inspect workpiece and repeat steps 8-12 as necessary until the end is smooth.

13. Stop spindle when end is smooth; check end for flatness with 6" rule. (If end is flat, continue to step 14.) If steel rule rocks, tighten tool or carriage and take another cut. _ _ _ _

NOTE: The end of the workpiece can also be rounded from pressure pulling the carriage or compound.

14. If time permits, continue with next job sheet; if not, clean machine, put away all tools and put part in locker. _ _ _ _

Average of above evaluations* _ _ _ _

*This average is the student's final evaluation for competency I7: Face workpiece and center drill.

TURN WORKPIECE BETWEEN CENTERS

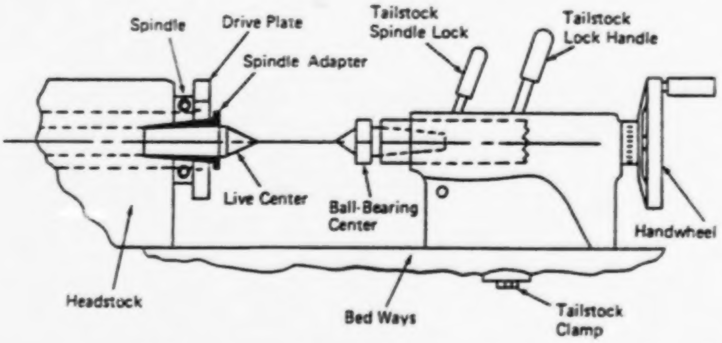
Equipment:

Right-hand turning tool
Steel rule, 6"
Live center
Spindle adapter
Drive plate
Ball-bearing center for tailstock
Quick-change tool post and toolholders
Bent-tail lathe dog or clamping lathe dog and wrenches
Wrenches to remove chuck and for
  tool post and compound

Clean shop cloth
Steel bar, SAE 4140, 1 1/2" diameter, 7" long
Lubricating oil
Micrometer, 1" to 2"
Cutting oil
Combination drill and countersink, #4
Drill chuck and key with arbor to fit tailstock
Facing tool
Dial indicator
Pencil

Procedure:

1. Check oil levels and perform daily maintenance.
2. Chuck workpiece in lathe. Face end smooth.
3. Center drill end of workpiece.
4. Turn end-for-end and face to 6 3/4" long. Center drill end and remove workpiece from chuck.
5. Remove lathe chuck and drill chuck. Set up lathe to turn between centers.


Spindle
Drive Plate
Spindle Adapter
Tailstock Spindle Lock
Tailstock Lock Handle
Live Center
Ball-Bearing Center
Handwheel
Headstock
Bed Ways
Tailstock Clamp

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 393.

a. Wipe off spindle. Wipe off spindle adapter and apply a thin coat of oil; seat adapter in spindle.

b. Mount drive plate to spindle nose; secure in place.

c. Wipe off live center; oil and seat in spindle adapter.

d. Check to see if live center is running true; if not, remove, clean all surfaces and reseat; then check again for alignment.

   NOTE: This check can be done with a dial indicator.

e. Clean taper in tailstock, wipe off ball-bearing center and seat in tailstock.

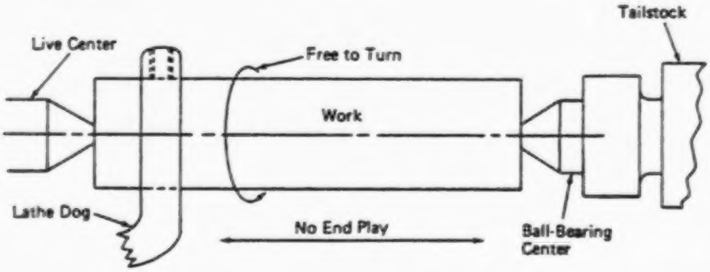
6. Put lathe dog on workpiece so that tail of dog is pointing to left.

7. Crank spindle of tailstock out about 1 1/2"; make sure spindle lock and tailstock lock are loose. Place center-drilled hole on live center with lathe dog tail to left; hold in place with left hand.

8. Slide tailstock up; guide ball-bearing center into hole and lock tailstock spindle in place.

9. Turn tailstock handwheel to lock part between centers with pressure; loosen pressure until workpiece turns freely by hand on centers.

   NOTE: Workpiece should not have any end play. See below. The purpose of the workpiece's face movement is to allow for expansion of material as it heats up from turning.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 394.

10. Slide tail of lathe dog into slot in drive plate and tighten in place.

    CAUTION: Tail of dog should fit freely in slot.

11. Mount turning tool in toolholder and adjust to center height. Set tool so that cutting edge has about a 10° lead angle.

12. Mark line on workpiece with pencil 4 1/2" from end near tailstock; put point of tool at this line and turn workpiece a complete revolution by hand to make sure tool can cut this far and still have clearance between lathe dog and tool post.

13. Move tool toward tailstock to see if point will clear end about 1/2"; if not, loosen tailstock crank spindle until carriage can move enough to clear tool; retighten and adjust workpiece.

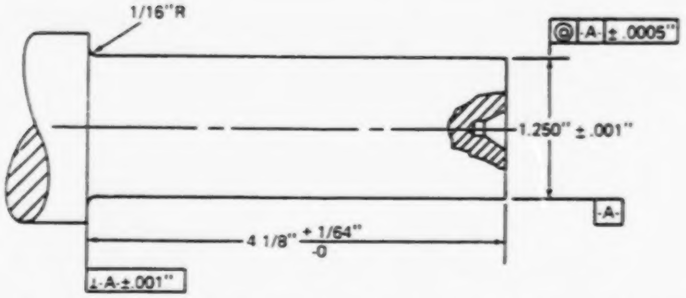
14. Set spindle speed at 240 rpm with a feed rate setting of 0.015 ipr for rough turning. Start spindle and turn workpiece to 1.300" x 4 1/8"; stop spindle and check workpiece for straightness by checking diameters along length of workpiece.

    NOTE: If workpiece does not measure 1.300" ± 0.001" along the length, the tailstock may be out of alignment; if so, check with instructor.

15. Turn workpiece to a finished diameter of 1.250" ± 0.001" x 4 1/8" long with square shoulder having a radius of 1/16".

    NOTE: For finish cut, speed should be increased to 384 rpm with a feed rate of 0.007 ipr.

16. Face shoulder.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 397.

17. Stop spindle and check diameter; remove additional material if necessary.

18. Turn off power, clean machine and put away all tools.

	Evaluation			
Product evaluation:	3	2	1	N
1. Length 4 1/8" +1/64" -0.00"				
2. Diameter 1.250 ± 0.001				
3. 1/16 radius ± 1/32				
4. ⊥ -A- ± 0.001				
5. ◎ to -A- ± 0.0005				
Average of above evaluations*				

*This average is the student's final evaluation for competency I11: Face workpiece and center drill.

JS 2.3

CENTER WORKPIECE IN FOUR-JAW CHUCK

Equipment:

Plunger-type dial indicator
Magnet-base indicator holder
Lathe with four-jaw chuck
Steel rule, 6"
Wrenches for chuck
Steel bar, SAE 1018, 2 1/2" diameter, 4" long
Pencil

		Evaluation			
Procedure:		3	2	1	N
1.	Mount four-jaw chuck, if not already on machine. Put lathe in neutral or release belt tension so that chuck can be turned by hand. Open jaws of chuck to approximately 1 1/2" diameter and insert round steel part.	___	___	___	___
	NOTE: Use steel rule and circular lines on face of chuck when opening jaws.				
2.	Snug jaws down on part by tightening them at 90° angles to each other, just tight enough to hold part secure. Mount indicator to magnetic base.	___	___	___	___
3.	Put magnetic base on cross slide or compound with dial facing you; check to see that magnet is secure. Move carriage toward headstock until indicator is approximately 1/4" above.	___	___	___	___
4.	Grasp pencil in right hand, steady your arm on toolholder or bed of machine, start rotating chuck with left hand and slowly move pencil toward part until you make a mark.	___	___	___	___
	NOTE: This mark is at the **high point**.				
5.	Loosen jaw opposite high side and tighten high side a little; retighten adjusting screw on low side.	___	___	___	___
	NOTE: Always work with opposite jaws.				
6.	Wipe off pencil mark and turn part while holding pencil close to workpiece; keep turning and move pencil forward slowly to find new high point.	___	___	___	___
7.	Loosen screw on low side and tighten new high side.	___	___	___	___
8.	Check with pencil again; if pencil marks workpiece approximately three-fourths of way around circumference, use the indicator. If not, continue to adjust until mark is made on approximately three-fourths of circumference.	___	___	___	___
9.	Move indicator down until point touches workpiece; turn cross-feed handwheel, moving indicator back and forth over workpiece. When indicator needle is at its maximum reading, stop and adjust dial to read zero.	___	___	___	___

NOTE: The straighter the indicator plunger is to the workpiece, the less error there will be.

10. Rotate workpiece and note the difference; loosen screw on low side and tighten high side, shifting part approximately half the difference. ___ ___ ___ ___

11. Continue this process until the needle of the indicator shows no movement. ___ ___ ___ ___

    NOTE: When there is only 0.003" or 0.004" difference, you can usually tighten only the high side half the difference.

    CAUTION: Work with opposite jaws. Never loosen adjoining jaws or the part will fall out.

12. When workpiece is true, ask instructor to check alignment. ___ ___ ___ ___

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

    NOTE: If this job sheet took more than five minutes to perform, practice procedures until more proficient.

Average of above evaluations* ___ ___ ___ ___

*This average completes the student's evaluation for competency I12: Center workpiece in four-jaw chuck.

JS 2.4

DRILL AND REAM HOLES

Equipment:

Facing tool
Combination drill and countersink, #4
Lathe with chuck and tailstock center
Steel rule, 6"
Drill chuck and key, 0-1/2" capacity with arbor to fit tailstock
Wrenches for chuck, compound and toolholder
Quick-change tool post and toolholder
Cutting oil
Drill, 31/64"
Reamer, 1/2" (0.500")
Steel bar, SAE 1020, 2 1/2" diameter, 1 15/16" long
Clean shop cloth

Procedure: Evaluation 3 2 1 N

1. Check oil levels and perform daily maintenance. ___ ___ ___ ___

2. Chuck workpiece. ___ ___ ___ ___

3. Face end of workpiece. ___ ___ ___ ___

4. Mount chuck on tailstock and center drill workpiece. ___ ___ ___ ___

5. Insert 31/64" drill in drill chuck. Set speed at 744 rpm. ___ ___ ___ ___

$$\text{rpm} = \frac{4 \times \text{CS}}{\text{Diameter of drill}}$$

$$= \frac{4 \times 90}{0.484}$$

$$= 743.8$$

CS = 90 sfpm
4 = constant
Diameter of drill = 31/64" = 0.484"

6. Position drill so that tailstock spindle is well into housing with point of drill about 1/4" from end of workpiece; lock tailstock in place. ___ ___ ___ ___

7. Start spindle and feed drill into workpiece with tailstock handwheel; at the same time, apply cutting oil to drill. Continue to feed drill in about 1"; back drill out of hole to clear chips; apply more cutting oil and continue drilling until hole is through workpiece. ___ ___ ___ ___

8. Withdraw drill and stop spindle. Remove, clean and put away drill. ___ ___ ___ ___

   CAUTION: Use a cloth to remove drill from chuck because it will be hot.

9. Insert 1/2" reamer in drill chuck; slide tailstock forward until reamer is 1/4" from stock; lock tailstock in place. Set rpm for reaming. ___ ___ ___ ___

NOTE: Reaming speeds should be about one-half of drilling rpm.

10. Start spindle, apply cutting oil to reamer. Crank reamer into hole with tailstock handwheel using a slow, continuous motion until reamer point has cut length of workpiece; crank reamer out of hole. _ _ _ _

CAUTION: Never ream a hole in which there is more than 1/16" difference between the diameter of the hole and that of reamer.

11. Turn off power, clean machine and put away all tools and materials. _ _ _ _

12. Turn in part to instructor for evaluation. _ _ _ _

Average of above evaluations* _ _ _ _

*This average is the student's final evaluation for competency I13: Drill holes and I14: Ream holes.

BORE HOLES

Equipment:

Lathe with chuck, tailstock center and carriage stop
Tool post with 3/4" boring bar holder and toolholder
Boring bar or tool bit ground for boring
Steel rule, 6"
Cutting oil
Drill chuck with arbor to fit tailstock
Right-hand facing tool
Combination drill and countersink, #4
Drill, 5/16"
Drill, 15/16"
Set of telescoping gages
Micrometer, 1-2"
Depth micrometer, 0-1"
Steel bar, SAE 1020, 2" diameter, 2 1/4" long
Wrenches for chuck, compound, toolholder, boring bar and drill chuck
Clean shop cloth

Procedure:

1. Check all oil levels and perform daily maintenance.

2. Bore a hole to size.

   a. Chuck workpiece with about 3/4" protruding past chuck jaws.

   b. Face end smooth.

   c. Center drill and drill 5/16" pilot hole through workpiece.

      NOTE: It is recommended that a pilot hole be drilled for drills 3/4" in diameter or larger. The pilot drill size should be about 1/32" larger than the web of the drill size.

   d. Drill 15/16" hole through workpiece.

   e. Mount boring bar in toolholder with a maximum of 3 1/4" of bar extending from the toolholder.

      NOTE: To eliminate spring and chattering, the boring bar should always be as short as possible.

      CAUTION: Care must be taken when setting up for boring to make sure the chuck does not strike compound.

   f. Set compound 30° to right of cross-feed and align boring bar parallel to ways; check to see if boring bar will clear through workpiece. Set carriage stop to allow cutting tool to clear hole by about 1/8".

   g. Set speed at 512 rpm with a feed of 0.007 ipr. (Roughing is 0.050" in depth.)

      EXAMPLE: $\text{rpm} = \dfrac{4 \times CS}{\text{Diameter of bore}}$

$$= \frac{4 \times 120}{0.938}$$

$$= 512 \text{ rpm}$$

h. Engage power feed and rough bore to 1.380", applying cutting oil as required during boring.

i. Set speed at 362 rpm with a feed of 0.005 ipr and make a 0.010" finish cut for measuring.

j. Use telescoping gages to measure bore.

k. Subtract bore measurement from 1.409 to determine amount remaining.

l. Advance tool to remove required amount; measure and rebore as necessary to a diameter of 1.409" + 0.010".

3. Bore a shoulder 1 3/4" x 3/8" deep using the same boring bar or a tool ground from high-speed steel. Align compound parallel to axis of workpiece. Position tool for clearance at the end and at the cutting edge.

NOTE: The tool is ground to an angle of less than 90° so that bore and shoulder can be squared.

a. Set rpm at 341 and feed rate at 0.010 ipr.

b. Position tool slightly outside bore about 1/16" from end of workpiece.

c. Move carriage stop up to carriage and lock in place; start spindle; advance compound until tool just starts to cut on end of workpiece, then zero the collar of the compound.

d. Move carriage to right about 1/2" and advance compound to move tool 0.375"; crank in cross-feed so that tool will not cut if it moves into bore.

e. Move carriage to left until tool is inside hole 1/8"; slowly crank cross-feed counter-clockwise until tool shaves wall of bore.

f. Move carriage to right until tool is clear of workpiece 1/8"; zero collar on cross-feed.

g. Turn cross-feed counter-clockwise and move tool so that a cut of 0.050" can be made.

h. Engage power feed and make a cut, allowing carriage to make contact with carriage stop; apply cutting oil as required during boring.

NOTE: A cut of 0.050" will enlarge the bore 0.100". Do not crank cross-feed in each time tool is cleared for next cut.

i. Continue to take cuts of 0.050" until bore is 1.709" (three cuts of 0.050"); decrease speed to 293 rpm and make a 0.010" cut at a feed rate of 0.005 ipr.

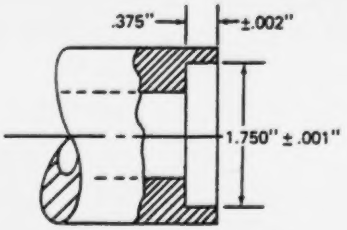
j. Stop spindle; use telescoping gage to gauge bore and measure with a micrometer; subtract measurement from 1.750" to obtain amount required to be removed for correct diameter.

k. Continue to machine by making cuts of 0.010" or less until bore is to size.

l. When bore is to size, the shoulder will not be smooth, so hold carriage on carriage stop with one hand and crank cross-feed into center of bore until tool quits cutting; then clear tool from bore and stop spindle.

NOTE: Before moving cross-feed in, note setting of graduated collar; if the bore needs opening up more, you will know where the tool was during last cut.

m. Measure workpiece and cut as necessary to obtain correct dimensions.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 422.

4. Remove workpiece from chuck and turn end-for-end; rechuck.

5. Bore a taper (angular boring).

   a. Face end of part smooth.

   b. Set compound 30° to right of cross-feed slide.

   c. Set tool to center height.

   d. Position tool post so that cutting edge of tool has proper clearance to cut end of bore at the 30° angle of feed.

   e. Set speed at 340 rpm and start spindle.

   f. Move carriage to position tool 1/16" from end of workpiece.

   g. Advance tool with compound until it just starts to cut end of workpiece; then move tool in to edge of bore with cross-feed.

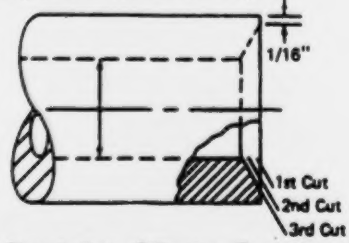
   h. Turn compound rest feed handle counter-clockwise to move tool 1/8" from end; turn cross-feed counter-clockwise to move tool 0.100" toward you.

   i. Applying cutting oil as required during cutting, advance tool with compound, feeding compound continuously until tool stops cutting.

   j. Clear tool by turning compound rest feed handle counter-clockwise so that tool is 1/8" from end of workpiece; move tool about 0.020" toward you with cross-feed and make another cut.

k. Stopping occasionally to check the workpiece, continue this process until 1/16" of faced area is left on end.

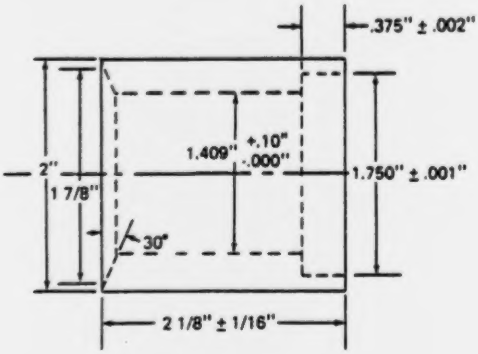
NOTE: Large diameter of taper will measure 1 7/8".



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 422.

6. Turn off power and clean machine. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.

Product evaluation:



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 427.

	Evaluation 3	2	1	N
1. Diameter of 1.409" bore	—	—	—	—
2. Diameter of counterbore	—	—	—	—
3. Depth of counterbore	—	—	—	—
4. Angle of taper ± 30°	—	—	—	—
5. Diameter of large end	—	—	—	—
6. Overall length	—	—	—	—
Average of above evaluations*	—	—	—	—

*This average is the student's final evaluation for competency I15: Bore holes.

JS 2.6

COUNTERSINK AND COUNTERBORE HOLES

Equipment:

Facing tool
Combination drill and #4 countersink
Lathe with chuck and tailstock center
Steel rule, 6"
Drill chuck, 0-1/2" capacity
Wrenches for chuck and toolholder
Toolholder
Cutting oil
Drill 1/4"
Countersink 90°
Counterbore, 1/2" with 1/4" pilot
Steel bar, SAE 1020, 1 1/2" diameter, 2" long
Clean shop cloth

NOTE: The instructor may elect to change the stock and tooling size. This job sheet is for evaluation purposes and is not an exact steps of procedure. The instructor will provide appropriate materials for the steps of procedure.

Procedure:	Evaluation 3	 2	 1	 N
1. Check all oil levels and perform daily maintenance.	___	___	___	___
2. Chuck workpiece.	___	___	___	___
3. Face end of workpiece.	___	___	___	___
4. Mount chuck or tailstock and center drill workpiece.	___	___	___	___
5. Insert combination drill and counter-sink on drill chuck.	___	___	___	___
6. Set speed at 1,440 rpm.	___	___	___	___

$$\text{rpm} = \frac{4 \times \text{CS}}{\text{diameter of drill}}$$

$$= \frac{4 \times 90}{.250} = 1{,}440$$

7. Position drill so that tailstock spindle is well into housing with point of drill about 1/4" from end of workpiece; lock tailstock in place.	___	___	___	___
8. Drill into workpiece 1"; back drill out of hole to clear chips. Use cutting oil.	___	___	___	___
9. Withdraw drill and stop spindle. Remove drill and replace with 1/2" counterbore. Set rpm for counterboring.	___	___	___	___

NOTE: Counterbore speed should be about one-half of drilling rpm.

10. Start spindle, apply cutting oil to counterbore and crank counterbore into hole with tailstock handwheel, using a slow continuous motion until cutting edge has cut to depth of 1/4"; crank counterbore out of hole.	___	___	___	___
11. Turn off power and reverse workpiece in chuck. Face end, repeating above steps 3-9.	___	___	___	___
12. Remove drill and replace with countersink. Set rpm for countersinking (1/2-2/3 drilling rpm).	___	___	___	___

13. Start spindle, apply cutting oil to countersink and crank countersink into hole with tailstock hand wheel, using a slow, continuous motion until cutting edge has produced an outside diameter of 1/2" inch. Using 6" scale, crank countersink out of hole. ___ ___ ___ ___

14. Turn off power; remove all tooling; clear lathe and tooling; replace equipment to proper location. ___ ___ ___ ___

15. Turn in part to instructor for evaluation. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's final evaluation for competencies I16: Countersink holes and I17: Counterbore holes.

JS 2.7

KNURL PARTS

Equipment:

Medium knurling tool, diamond pattern
Lathe with chuck and tailstock center
Quick-change tool post and toolholders
Wrenches for chuck and toolholders
Steel rule, 6"
Steel bar, SAE 1018, 1" diameter, 4" long
Facing tool
Cutting oil
Brush and solvent
Lubricant
Clean shop cloth

Procedure:

1. Check all oil levels and perform daily maintenance.

2. Chuck workpiece with 2 3/4" protruding past chuck jaws.

3. Face end.

4. Clean knurling rollers with brush and solvent, then lubricate. Mount knurling tool on tool post.

   NOTE: There are several kinds of knurling tools; for this job sheet, use the fixed-holder type for quick-change tooling.

5. Adjust knurling tool to center height; lock.

   NOTE: If knurling tool is on center, both rollers will make contact with workpiece surface at the same time, with the center axis of the workpiece aligned with the midpoint between the rollers.

6. Set the feed for a medium-grade knurl.

   NOTE: Knurls have three grades of coarseness: fine, medium and coarse.

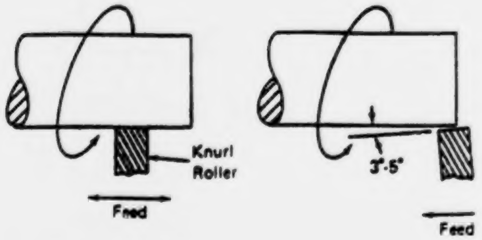
   EXAMPLES:
   Fine--32 pitch or 0.031 ipr feed
   Medium--20 pitch or 0.050 ipr feed
   Coarse--13 pitch or 0.076 ipr feed

7. Set knurling rpm at about one-fourth the turning rpm for the same size and type of material.

   EXAMPLE: A 1" medium carbon steel rod will turn at 300 rpm; 1/4 of 300 is 75 rpm.

8. Loosen tool post and adjust rollers of knurling tool so that they are square to workpiece.

   NOTE: When knurling hard material, rollers are set 3-5° off square.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 375.

a. Check tool for squareness by placing a strip of paper between workpiece and rollers.

b. Advance cross-feed until there is slight pressure on paper.

c. Place spindle in neutral and revolve chuck by hand.

d. Inspect paper.

NOTE: If tool is square and on center height, a clear diamond pattern will be produced the width of the rollers. Double-tracking (twice as many lines in one direction as in the other direction) occurs when knurling tool is not on center or rollers are dirty.

e. Adjust as necessary.

9. Mark a line 1 3/8" from end of workpiece.

10. Engage spindle and position tool so that half of roller is on workpiece; advance cross-feed until tool begins to form a diamond pattern.

11. Apply cutting oil to rollers and workpiece.

CAUTION: Do not get brush or tip of oil can close to rollers, and never touch rollers while they are revolving. Objects caught between rollers and workpiece will be pulled through or can damage rollers or workpiece.

12. Engage power feed and allow carriage to move until rollers reach 1 3/8" line.

13. Stop spindle and examine knurl; if knurls have not peaked out, apply oil, start spindle and move tool back across knurling.

CAUTION: Do not allow rollers to move past end of workpiece.

14. Repeat steps 11-13 as necessary with a deeper feed until knurls peak out.

15. Stop spindle and clean tool.

16. Mark a line 1 3/4" from end of workpiece and another line 2 1/4" from end; center rollers between lines.

17. Start spindle, advance knurling tool and apply cutting oil to rollers. Moving the carriage by hand to lines, repeat knurling procedure until knurls have peaked out.

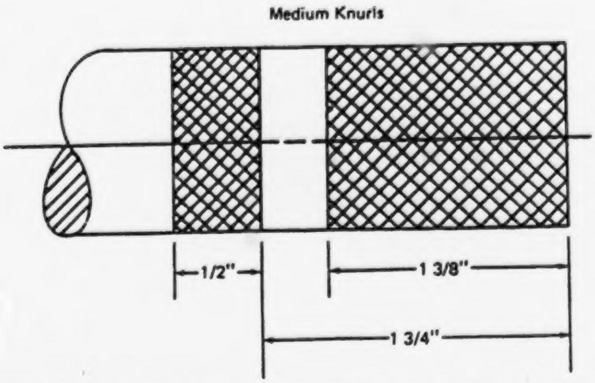
18. Stop spindle and clear tool from workpiece.

19. Turn in workpiece to instructor.

20. As directed by instructor, prepare for next job sheet or turn off power, clean knurling tool and return tools and materials.

Product evaluation

Evaluation



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 379.

	3	2	1	N
1. Knurls	___	___	___	___
2. 1/2" length	___	___	___	___
3. 1 3/8" length	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's final evaluation for competency I18: Knurl parts.

MODULE: LATHES

UNIT X: ADVANCED LATHE SET-UP AND OPERATION

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to set up and perform advanced lathe operations using the steady rest, follower rest and faceplate work-holding devices. The student should also be able to groove, undercut, thread and taper using the engine lathe. This knowledge will be evidenced by achieving specified scores on the assignment sheet and job sheets.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms and definitions associated with advanced tool holding set-up and operations. (AS 1.1)

1.2 Turn or thread long workpieces using the steady rest. (competency I30, JS 2.1)

1.3 Turn or thread long workpieces using the follower rest. (competency I30, JS 2.1)

1.4 Align workpiece on faceplate. (competency I27, JS 2.2)

1.5 Identify uses for undercutting. (AS 1.1)

1.6 Identify uses for grooving. (AS 1.1)

2.1 Demonstrate the ability to:

- a. Cut multiple threads. (competency I31, JS 2.3, 2.4)
- b. Cut Acme threads. (competency I32, JS 2.4)

2.2 Demonstrate the ability to:

- a. Cut/chase external threads. (competency I20, JS 2.4)
- b. Cut/rechase internal threads. (competency I21, JS 2.5)
- c. Chase/rechase metric threads. (competency I22, JS 2.6)

2.3 Demonstrate the ability to:

- a. Use compound rest to cut short external tapered surface. (competency I23, JS 2.7)
- b. Cut tapers by offset tailstock. (competency I24, JS 2.8)
- c. Cut an external tapered surface with taper attachment. (competency I25, JS 2.9)
- d. Cut internal tapered surface with taper attachment. (competency I26, JS 2.9)
- e. Use form tooling, polish workpiece and perform lathe filing. (competencies I28, 29, 33, JS 2.10)

MODULE: LATHES

UNIT X: ADVANCED LATHE SET-UP AND OPERATION

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: LATHE OPERATIONS AND TOOLING

   a. Information outline

   b. Assignment sheet

      AS 1.1: Set-up methods and terms

2. Lesson 2: LATHE THREADING AND TAPERING

   a. Information outline

   b. Job sheets

      JS 2.1: Turn or thread long workpieces using follower and steady rest
      JS 2.2: Align workpiece on faceplate
      JS 2.3: Prepare workpiece for threading
      JS 2.4: Cut/chase external, multiple and Acme threads
      JS 2.5: Cut/rechase internal threads
      JS 2.6: Chase/rechase metric threads
      JS 2.7: Use compound rest to cut short external tapered surface
      JS 2.8: Cut tapers by offset tailstock
      JS 2.9: Cut external and internal tapered surfaces with taper attachment
      JS 2.10: Use form tooling, polish workpiece and perform lathe filing

REFERENCES

A. Books

1. Harig, Herbert. Basic Precision Machining. Washington, DC: National Tool and Precision Machining Association, 1980.

2. Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985.

3. Krar, S. F. and J. W. Oswald. Grinding Technology. Albany, NY: Delmar Publishers, Inc., 1984.

4. Olivo, C. Thomas. Machine Tool Technology and Manufacturing Processes. Albany, NY: C. Thomas Olivo Associates, 1987.

B. Curriculum guides

1. Machinist. Frankfort, KY: Vocational-Technical Education Consortium of States, 1982.
2. Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983.
3. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Mandrels are used with lathes or grinders. It has been left up to the instructor to check off **competency I34:** Use mandrel, in either this or the grinder module (Unit III, JS 1.3).

B. Suggested supplemental materials

1. Publications
    - a. How to Run a Lathe. South Bend, IN: South Bend Lathe, 1966.
    - b. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.
    - c. Burghardt, Henry D.; Aaron Axelrod; and James Anderson. Machine Tool Operations. Part I and II. New York: McGraw-Hill, 1960.
    - d. Hardman, William E. Basic Machine Shop Theory. Ft. Washington, MD: National Tool and Precision Machining Association, 1982.
    - e. Repp, Victor E., and Willard J. McCarthy. Machine Tool Technology. 5th ed. Bloomington, IL: McKnight Publishing Co., 1984.

MODULE: LATHES

UNIT X: ADVANCED LATHE SET-UP AND OPERATION

LESSON 1: LATHE OPERATIONS AND TOOLING

I. Terms and definitions

  A. Bore--an existing hole in a workpiece; to perform the machining operation of enlarging an existing hole

  B. Chase--the repeated following of the threading tool in the thread helix being cut

  C. End play--movement longitudinally of a workpiece mounted between centered in a lathe

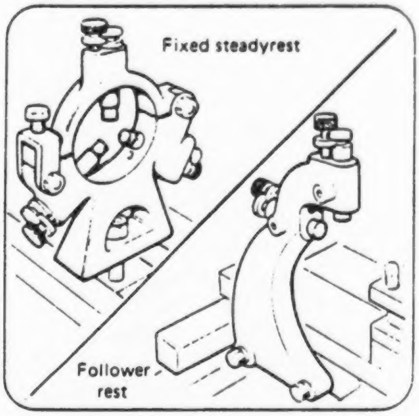
  D. Form--to machine a shape by a plunge cut and not use any traverse motion

  E. Form tool--a cutter ground to a specific shape and used in a plunge cut operation

  F. Stoning--deburring and removing rough edges of work, machine surfaces or tooling; using a hand stone

  G. Weights--metal slugs used to counterbalance off center or odd-shaped workpieces when they are mounted on faceplates

II. Using steady rests



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 87. Reprinted by permission of John Wiley & Sons, Inc.

  A. Considerations prior to set-up

    1. The most common applications of fixed steady rests

      a. Facing the ends of long bars too large in diameter to pass through the machine spindle

      b. Drilling, boring or tapping ends of long bars

    2. Limitations of fixed steady rest

a. Since the steady rest is clamped to the machine ways, the carriage cannot pass it.

b. A bar being turned must be machined at one end, reversed in the chuck and then machined at the other end.

c. The workpiece diameter where the steady rest pads will touch must be perfectly round, for any error will be reproduced on all machining operations.

B. Setting the fixed steady rest

1. Set up workpiece.

2. Position steady rest.

3. Set steady rest to workpiece diameter.

III. Using follower rest

A. Consideration prior to set-up

1. The follower rest is attached to the carriage of the lathe and travels along with the cutting tool.

2. The two steady points are positioned above and behind the workpiece diameter.

3. The points should be set to travel just behind the cutting tool, so that the point pads support the portion of the workpiece that the tool has just machined.

4. The most common application for follower rests is for turning long shafts where it is inconvenient for the bar to be reversed in the chuck.

B. Setting the follower rest

1. Set up workpiece.

2. Position follower.

3. Set follower to workpiece diameter.

4. Turn diameter

IV. Using the faceplate

A. Mounting workpiece on the faceplate

1. Mount faceplate.

CAUTION: If faceplate is too heavy to lift manually, use a rope sling passed through one of the slots in the faceplate. (A chain should only be used if a shackle is bolted to the faceplate and the chain passed through it.)

2. Check faceplate for squareness.

3. Select clamps, clamping bolts and packing pieces.

4. Check location face of workpiece.

5. Position clamps on faceplate.

6. Clamp workpiece to faceplate.
7. Position workpiece.
8. Check for clearance.

B. Using the angle plate bolted to the faceplate

   1. Mount angle plate to faceplate.
   2. Mount workpiece to angle plate.

      NOTE: The workpiece is normally pre-machined on one or two faces to give a flat location face.

   3. Check for out-of-balance state.
   4. Check for off-balance condition.
   5. Recheck for off-balance condition.
   6. Machine workpiece.

V. Undercutting

A. Undercutting an outside diameter at a shoulder

   1. Turn workpiece.
   2. Set undercutting tool.
   3. Position tool for undercut.
   4. Undercut diameter.

B. Undercutting a shoulder

   1. Turn workpiece.
   2. Set undercutting tool.
   3. Position tool for undercut.
   4. Undercut shoulder.

VI. Grooving

A. External grooves

   1. Set tool.
   2. Set tool position from end face.
   3. Set tool position from a shoulder.
   4. Cut groove.

B. Internal grooving

1. Set tool.
2. Set tool position from end face.
3. If required movement is greater than compound slide capacity, set tool position from end face with this method.
4. Cut groove.

AS 1.1

SET-UP METHODS AND TERMS

Match the following terms and definitions.

____ 1. A cutter ground to a specific shape and used in a plunge cut operation

____ 2. An existing hole in a workpiece; to perform the machining operation of enlarging an existing hole

____ 3. Metal slugs used to counterbalance off center or odd-shaped workpieces when they are mounted on faceplates

____ 4. Movement longitudinally of a workpiece mounted between centered in a lathe

____ 5. The repeated following of the threading tool in the thread helix being cut

____ 6. To debur and remove rough edges of work, machine surfaces or tooling; to use a hand stone

a. Bore

b. Chase

c. End play

d. Form

e. Form tool

ab. Stone

ac. Weights

Select "a" for true statements and "b" for false ones.

____ 7. Undercutting can be done anywhere that grooving can.

____ 8. Grooving cannot be used on internal parts.

ANSWERS TO AS 1.1

1. e
2. a
3. ac
4. c
5. b
6. ab
7. b
8. b

MODULE: LATHES

UNIT X: ADVANCED LATHE SET-UP AND OPERATION

LESSON 2: LATHE THREADING AND TAPERING

I. Tapping holes

- A. Considerations prior to set-up
    1. Select proper sized tap drill that will yield a correct percentage of thread depth.
    2. Tap drill size can be calculated using formulas or tables.
- B. Tapping through holes
    1. Prepare workpiece.
        - a. Face off end of workpiece where tapped hole is required.
        - b. Move cutting tool away from workpiece.
    2. Center drill by mounting center drill in chuck, selecting speed and center drilling end of workpiece.
    3. Drill.
    4. Set for tapping.
    5. Tap hole.
        - a. Turn tap wrench clockwise approximately two full revolutions.
        - b. Reverse tap approximately half revolution. This will break chip and stop tap from clogging or jamming in hole.
        - c. Repeat the process of turning tap 1-2 revolutions and reversing for half revolution until hole is tapped through, ensuring at all times that tailstock center is in contact with tap.
    6. Check thread by cleaning chips fromt apped hole and checking thread with correct screw plug gage.
- C. Tapping blind holes
    1. Prepare workpiece--face off and move tool away.
    2. Center drill.
    3. Drill to required depth. Drill must be taken 1/16"-1/8" deeper than the required length of full thread.
    4. Set for tapping.
    5. Tap hole to depth.

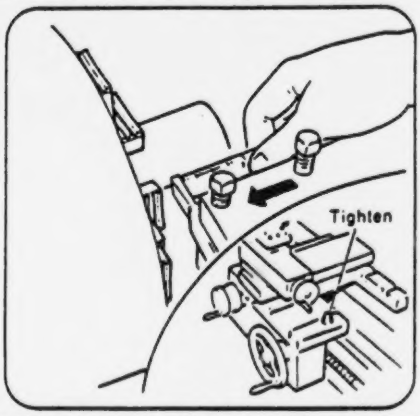
NOTE: Use bottom tap on blind holes to ensure full depth of thread. Do this after the first or second tap has been used.

D. Parting off

1. Set workpiece in chuck, allowing width of parting tool plus 1/4" clearance of tool to chuck jaws. Keep overhand to a minimum.

2. Set parting tool in holder. (Center height and squareness is critical.)

3. Hold ruler to side of tool and move carriage along until required length on scale is aligned to workpiece face.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 142. Reprinted by permission of John Wiley & Sons, Inc.

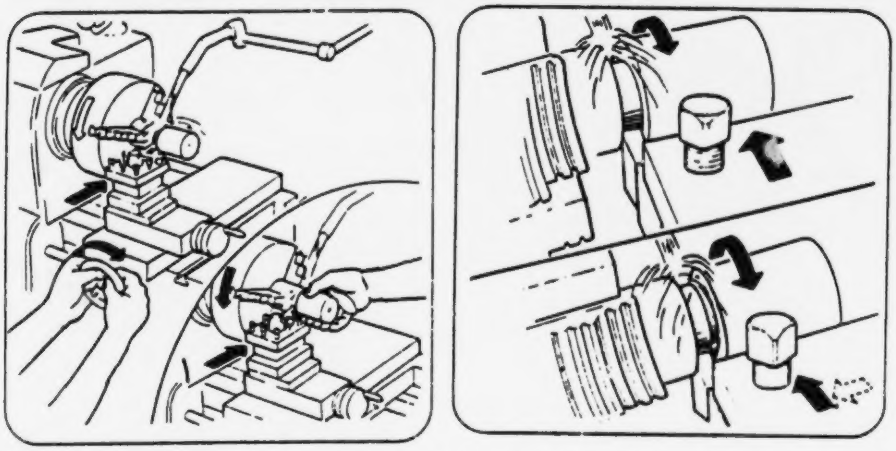
4. Clamp carriage to ways.

5. Start spindle and apply sufficient coolant or cutting oil to tool.

6. Hand feed parting tool into workpiece, maintaining even feed rate.

7. Remove burrs from corner of parting slot with file before completing parting off.

CAUTION: Make sure the file used has a fitted handle.



Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 143. Reprinted by permission of John Wiley & Sons, Inc.

8. If chips build up in parting slot while cutting, move tool clear of slot.

9. Move cross slide, moving tool approximately half its width toward chuck.

10. Hand feed parting tool into workpiece inward approximately 1/4" more than previous cut.

11. Withdraw tool and return it to its original position on cross slide.

12. Feed in tool by hand to part off work.

II. Thread cutting and chasing set-up

A. Thread cutting and chasing

1. Tool preparation

a. Grind tool to correct form for thread required.

b. Check tool form with center gage.

c. Threading tool should be flat on top.

2. Machine set-up

a. Determine proper number of threads per inch (tpi).

b. Position quick-change gear box controls for correct lead.

c. Set machine in position so that lead screw will operate.

d. Set compound rest slide at an angle of 29 1/2 right (for external threads).

e. Be sure that compound slide has sufficient travel to accommodate required thread depth.

f. Set tool in tool holder and adjust to center height.

g. Use center gage to position tool square to workpiece.

3. Cut first pass

4. Cut thread

B. Picking up an already-cut or partially cut thread

1. Considerations prior to setting up

a. If workpiece is removed from machine before the thread is completed or if an existing thread must be extended or repaired, threading tool must be positioned to travel in the existing thread helix.

b. The example procedures are used for a 60° sharp or American National thread form.

2. Setting up

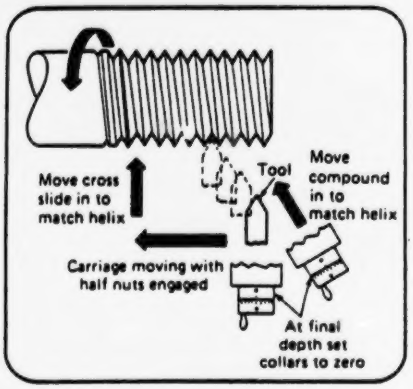
a. Grind tool to proper form. Position at center height and square to workpiece.

b. Set compound at 29 1/2° right (for external threads); be sure that slide has sufficient travel to reach desired thread depth.

c. Back cross slide out so that tool is well clear of work.

d. Start spindle and engage half nut lever at proper line on thread chasing dial. Permit carriage to travel a short distance over threaded portion of workpiece.

e. Stop spindle, leaving half nuts engaged.


Move cross slide in to match helix
Tool
Move compound in to match helix
Carriage moving with half nuts engaged
At final depth set collars to zero

Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 169. Reprinted by permission of John Wiley & Sons, Inc.

f. Move tool up to workpiece using a combination of cross slide and compound movement. Tool will be advanced by cross slide and will also be moved sideways because of compound angle. This permits alignment of tool with thread position (see above illustration).

g. When tool reaches depth of existing thread and is properly positioned sideways, set cross slide and compound collars to zero.

h. If the existing thread is already at full depth, tool will be positioned too deep to continue threading. Back out cross slide and workpiece threading depth down to existing depth by making several passes.

NOTE: Do not use cross slide to in-feed because this would cause incorrect tool positioning.

i. Take a clean-up cut; test measure thread before removing from set-up.

C. Internal thread cutting

1. Considerations prior to setting up

a. Internal threads are cut on the lathe much in the same way as external threads.

b. The cutting tool is usually held in a boring bar if the thread to be cut is quite deep.

c. A shallow internal thread can be cut with a suitable threading tool clamped directly in the tool holder.

d. Care must be taken; if the thread is not all the way through, the tool must be stopped before it hits the end of the hole or internal shoulder.

e. A relief groove machined at the end of the thread will permit the tool to pass clear at the end of the threading pass.

f. The relief groove diameter must be slightly larger than the major diameter of the thread being cut.

2. Prepare workpiece.

   a. Bore or drill workpiece to correct size. (Calculate minor diameter for hole size.)

   b. Cut thread relief groove at end of thread, if necessary.

3. Set up machine.

   a. Set compound at 29 1/2° left for unified internal threads.

   b. Set tool in tool holder and adjust to center height.

   c. Square cutter to workpiece using center gage.

   d. Set quick-change gear box to chase desired number of threads per inch.

4. Cut thread

D. Cutting other thread forms

1. Other thread forms, such as Acme, square and buttress are cut in much the same manner as unified forms.

2. The cutting tool must be ground to the correct shape.

3. Special compound angles must be set for each thread.

4. Specifications for other thread forms can be found in the Machinist's Handbook and other references.

E. Thread cutting using stocks and dies (manually)

NOTE: For small thread sizes it is practical to cut the thread completely with the single-point tool. For large threads a die is best used to clean up and to complete the form of a thread partially cut with a single-point tool.

1. Prepare diameter to be threaded.

   a. Turn to .003" below nominal thread diameter.

   b. Apply cutting oil to workpiece surface.

2. Set die in stock.

   a. Ensure that die fits squarely on the back face of stock recess.

   b. Set die for roughing cut (see above illustration).

3. Position tailstock to support die.

   a. Place die stock assembly over end of workpiece diameter (see illustration below).

b. Slide tailstock forward to hold die stock lightly in position.

c. Lock tailstock to ways.

d. Use light force--excess tailstock pressure against die can cause damage.

4. Cut thread (machine out of gear).

a. Rotate chuck by hand until die stock handle rests on tool post or cross slide.

b. Ensure that handle has free path forward.

c. Apply light forward pressure on die with tailstock barrel. Turn chuck by hand to cut thread to required length. Back up after each turn to break chips.

d. Check thread for size using gage or mating component.

e. Adjust die for second cut.

f. Recut as above.

F. Thread measurement

1. Screw pitch gages are used for checking pitch of internal and external threads. The gages have two sets of pivoted blades in a metal case. On the edge of each blade there are teeth corresponding to pitch.

2. Thread plug gages are used for checking internal threads, tapped holes and so on. The gage is double-ended. The go end has a full form thread, and the no-go end has a short thread with a blunt thread form.

3. Thread micrometers are used to measure thread pitch. The spindle has a 60° conical point, and the anvil has a matching groove. Measurement is taken in the same manner as a standard micrometer.

4. Thread ring gages are screwed onto the workpiece; play is felt by rocking the gage back and forth along the thread. If the thread is satisfactory, the gage should screw on without any interference or rocking over the complete thread length.

III. Methods used to set up and perform tapering operations

A. Taper turning using a form tool (plunge cutting angles): a method for producing short tapers of any angle, external or internal; uses a form tool

1. Prepare workpiece (external).

a. Mount workpiece in machine, keeping section to be tapered as close to chuck as possible.

b. Finish turn to length and diameter.

2. Select tool form.

a. For 30-, 45- and 60-degree angles, standard tools can be used. For other angles, select a tool approximating the required angle.

b. Check that tool face is long enough to produce complete taper in one cut.

3. Set tool.

4. Turn taper to given diameter.

5. Turn taper to given length.

B. Taper turning using the compound slide: a method allowing both external and internal tapers of any angle to be produced. Taper length is limited to the travel of the hand-operated compound slide.

   1. To cut external taper, first ensure that compound slide movement will enable full length of taper to be turned.

   2. Prepare workpiece by turning parallel diameter(s) to maximum diameter of taper.

   3. Set compound slide angle.

   4. Set tool on true center height perpendicular to surface to be turned. Bring tool to working position and, by using compound slide, ensure that full taper can be turned without obstruction.

      CAUTION: When working with the tailstock, it may be necessary to position the compound slide handwheel toward the headstock. Ensure that there is freedom to rotate the chuck before switching on. Keep hands clear of chuck or faceplate when operating compound slide handwheel.

   5. Turn taper.

   6. Check angle of taper (chalk method).

   7. Position tool for final cut to length.

      NOTE: For internal taper a similar procedure is followed using a suitably sized standard boring tool. The compound slide is set to the taper angle being cut.

C. Taper turning using the offset tailstock: a method limited to the production of shallow taper angles on workpiece turned between centers

   1. Prepare workpiece for turning between centers.

   2. Mount workpiece between centers.

   3. Turn all parallel diameters and faces.

   4. Calculate tailstock setover.

      a. Shallow angle tapers are usually dimensioned as a given amount of taper on diameter per foot of length.

         $\frac{D - d}{L}$ = setover where D = large end diameter
         d = small end diameter
         L = length

      b. This setover allows an approximate first setting to be made. Final adjustment is made by checking workpiece with a taper gage.

   5. Setover tailstock (using indicator).

   6. Remount workpiece between centers.

6. Remount workpiece between centers.

7. Turn taper.

8. Reset tailstock to spindle center line.

D. Taper turning using the taper turning attachment

1. Considerations before set-up

   a. When released from the direct control of the handwheel, the cross slide will move freely.

   b. The operation of the taper turning attachment is to control this movement within a slider so that the angle set on the attachment guide rail will be reproduced on the workpiece.

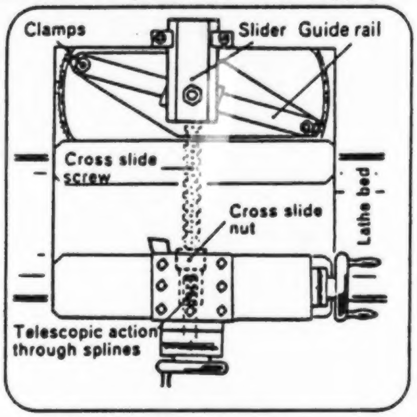
   c. Both internal and external tapers can be machined.

2. Mount workpiece.

3. Set tool on true center height. Any error here will result in an incorrect taper.

4. Turn parallel diameters.

5. Set taper turning attachment (telescopic screw type).


Clamps
Slider
Guide rail
Cross slide screw
Cross slide nut
Lathe bed
Telescopic action through splines

Credit: Kibbe, Richard R. Lathe Operations. New York: John Wiley and Sons, 1985, pg. 186. Reprinted by permission of John Wiley & Sons, Inc.

6. Turn taper.

JS 2.1

TURN OR THREAD LONG WORKPIECES USING FOLLOWER AND STEADY REST

Equipment:

Clean cloth	Blueprint or workpiece (see instructor)
Steady rest	Lathe tool
Dead center with sleeve	Oil/grease
Rotating center	Three-jaw chuck
	RH/LH lathe tool bit

Procedure: Evaluation 3 2 1 N

Setting the fixed steady rest

1. Set up. Select suitable workholding method; secure workpiece and set workpiece concentric. ___ ___ ___ ___

2. Position steady rest. Clean machine ways where steady rest is to be positioned. Clean underside of steady rest. Lift steady rest onto machine ways just clear of end of workpiece. Move steady rest jaws out to clear workpiece diameter. Slide steady rest to required position; secure it to machine ways. ___ ___ ___ ___

   NOTE: Steady rest position will depend on the operation to be performed. It should be as close as possible to the actual machining area.

3. Set steady rest to workpiece diameter. The workpiece should be supported at both ends before applying the steady rest pads to the diameter (between chuck and center). If this is impractical, pads should be brought up to nearly touch the diameter and the workpiece revolved by hand at a slow speed for final setting. The workpiece diameter where the steady rest pads will touch must be perfectly round--any error will be reproduced on all machining operations. ___ ___ ___ ___

   a. Start machine spindle.

      NOTE: If the workpiece is supported at both ends, use the speed that will be used when machining.

   b. Lightly tighten steady rest movable arm clamp. Move up nearest steady rest pad to workpiece diameter until a light feel of pad-to-diameter is obtained. Move up farthest steady rest pad to obtain same feel. Move down top pad to obtain same feel.

   c. Lightly turn each knurled screw of pads, allowing them to slip through fingers to ensure light contact of pads-to-diameter. Lock position of two bottom pads.

   d. Apply oil or grease between workpiece bearing diameter and steady rest pads.

      CAUTION: Use a small brush--not your fingers--to apply oil or grease.

   NOTE: It is most important to obtain the correct feel of the pads. For this reason, each pad of the steady rest should be free-moving.

Setting the follower rest

4. Set up workpiece. Select appropriate workholding method (as above); secure workpiece (as above). _ _ _ _

NOTE: When using a follower rest, the workpiece must be supported at both ends.

5. Position follower. Clean carriage where rest will be attached. Clean side of rest. Bolt rest to carriage, ensuring that pads clear workpiece diameter. _ _ _ _

6. Set follower to workpiece diameter. Set tool cutting edge approximately 1" in front of follower pads. Take cut approximately 1 1/2" along diameter of workpiece. (The depth of the cut should equal that which you intend to remove uniformly over the workpiece's length.) Move in rear follower pad to workpiece diameter until a light feel of pad-to-diameter is obtained. Move down top pad to obtain same feel. _ _ _ _

7. Turn diameter. Proceed to turn diameter. Allow good coolant flow where appropriate. Check feel of follower pads frequently. Finish turn diameter and length to instructor's specifications. _ _ _ _

8. Submit workpiece to instructor for evaluation. _ _ _ _

9. Clean machine and all equipment, returning tooling to proper location. _ _ _ _

Average of above evaluations* _ _ _ _

*This average is the student's final evaluation for competency I30: Turn or thread long workpieces using follower and steady rest.

JS 2.2

ALIGN WORKPIECE ON FACEPLATE

Equipment:

- Faceplate
- Clamping bolts
- Dial indicator with base
- Strap clamps
- Shims
- Clean cloth
- Protective board
- Oilstone
- Dead center
- Soft hammer

NOTE: Instructor will provide necessary blueprint or workpiece for this job sheet. The student is not to face off the faceplate unless directed by the instructor.

Procedure:	Evaluation 3	 2	 1	 N
1. Mount faceplate. Clean spindle nose; clean bore and location faces on faceplate. Place protective board across ways under spindle nose. Lift faceplate into position on spindle nose and fasten securely. Remove protective board.	__	__	__	__

CAUTION: If faceplate is too heavy to lift manually, slings can be used. A rope sling can be passed through one of the faceplate slots. If a chain is used, a shackle must be bolted to the faceplate and the chain passed through it.

2. Check faceplate for squareness.	__	__	__	__

a. Clean faceplate; check for burrs and high spots.

b. Mount a dial indicator on toolpost or cross slide.

c. Move saddle toward workpiece so that plunger of indicator touches faceplate and a reading is obtained.

d. Turn faceplate by hand; check reading on dial indicator. Any variation means that the faceplate is out of square. Before facing, make sure that error is not caused by burrs on mounting flange.

NOTE: If the faceplate is not square, it must be faced off with the lightest cut possible to true up. Remove burrs and recheck for squareness. Notify instructor.

3. Select clamps, clamping bolts and packing pieces. Measure length of workpiece to be clamped. Select bolts to cover this length plus thickness of faceplate and clamps, allowing approximately 1 1/2" for nuts. Select shims 1/32-1/16" longer than the length of workpiece to be clamped.	__	__	__	__

NOTE: The number of clamps depends on the workpiece size and weight.

4. Check location face of workpiece. Remove all burrs. Maximum contact must be obtained between workpiece and faceplate. Generally, machine the workpiece first on one face to provide for a flat set-up face.	__	__	__	__
5. Position clamps on faceplate by inserting bolts into approximate positions in faceplate and fastening clamps to bolts loosely.	__	__	__	__

6. Clamp workpiece to faceplate. ___ ___ ___ ___

   a. Locate center in tailstock.

   b. Place protective board on ways under faceplate. Hold workpiece up to faceplate.

   c. Bring up tailstock, advancing tailstock center into workpiece until pressure holds it to the faceplate.

      NOTE: The tailstock center is necessary for support only on heavy or awkwardly shaped workpieces. Normally, an old, soft center can be used for holding.

   d. Clamp workpiece to faceplate. Remove center. Remove protective board.

7. Position workpiece. Tap gently with a soft mallet until workpiece is in required position. Tighten all clamps. ___ ___ ___ ___

8. Check for clearance. Turn faceplate by hand. With tool in cutting position, check that clamps, bolts and workpiece do not hit lathe anywhere. ___ ___ ___ ___

9. Notify instructor for evaluation. ___ ___ ___ ___

10. Remove set-up and replace all tooling to proper location(s). ___ ___ ___ ___

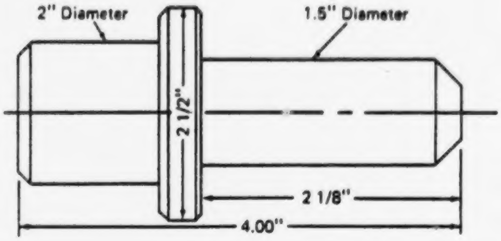
Average of above evaluations* ___ ___ ___ ___

*This average is the student's final evaluation for competency I27: Align workpiece on faceplate.

PREPARE WORKPIECE FOR THREADING

Equipment:

Recessing tool (1/8" wide) or cutoff blade (1/8" wide) and blade holder
Steel rule, 6"
Lathe with chuck and tailstock center
Quick-change tool post and toolholder
Wrenches for chuck, tool post, toolholders and carriage
Cutting oil
Vernier calipers
Clean shop cloth
Steel bar, SAE 1018, 2 1/2" diameter, 4" long

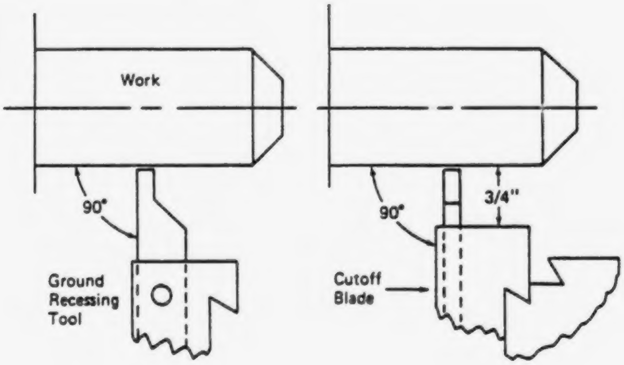


Art credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 361-364, 367.

1. Check oil levels and perform daily maintenance.

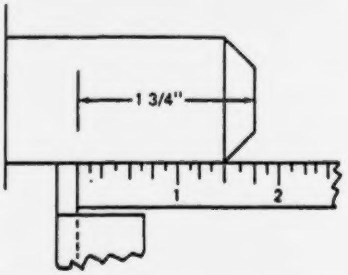
2. Chuck on 2" diameter of work. Mount recessing tool or cutoff blade in toolholder, mount toolholder on tool post and adjust to center height. Position end of tool square to work.

   NOTE: If using a cutoff blade, keep blade as short as possible.



3. Set speed at 176 rpm. Use steel rule to set tool 1 3/4" from end of work.

   NOTE: Depending on the accuracy of the recess location, depth micrometers, way indicators, travel dials or other tools can be used to determine recess location.



4. Back tool away from workpiece and snug carriage lock to prevent carriage from moving and possibly causing tool bind.

5. Turn on lathe, start spindle and crank cross-feed until tool starts to cut workpiece surface.

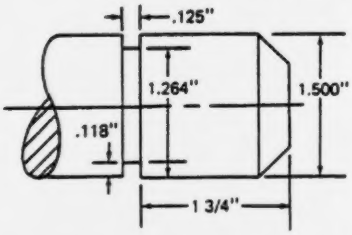
6. Stop spindle and zero cross-feed graduated collar. Check thread depth charts or calculate single depth of thread for eight threads.

   NOTE: This procedure produces sharp V threads. The constant for computing single thread depth for this form is 0.866.

   EXAMPLE: Single depth of thread = $\frac{0.866}{N} = \frac{0.866}{8} = 0.108"$

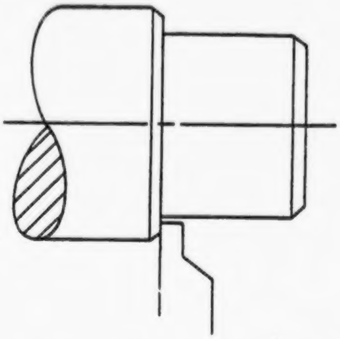
7. Start spindle and advance blade into workpiece with a slow, continuous motion; at the same time, apply cutting oil. Continue to feed tool until graduated collar shows that tool has moved 0.118", which is 0.010" more than single thread depth.

   NOTE: Depending on how cross-feed dial is graduated, dial can read 118 or 236.



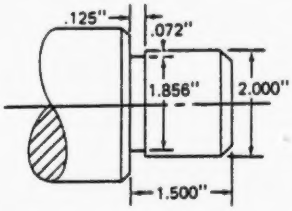
8. Stop spindle and inspect recess; check depth with calipers; recut as necessary. (Root diameter should measure 0.236" less than the major diameter.)

9. To cut a shoulder recess, turn workpiece end-for-end and chuck. Position tool square to work. Position tool next to shoulder.



10. Set rpm at 120. Start spindle. Advance tool with cross-feed until it just shaves 2" diameter; zero graduated collar.

11. Advance cross-feed and feed tool 0.072"; apply cutting oil as required during cutting.


.125"
.072"
1.856"
2.000"
1.500"

12. Check recess depth; recut as necessary.

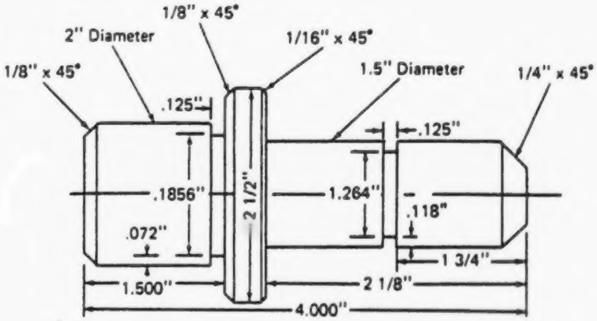
NOTE: Recesses for special applications may require grinding of a special tool.

13. Turn off machine and clean; put away tools.

14. Turn in workpiece to instructor for evaluation.

Product evaluation:

Evaluation
3 2 1 N


1/8" x 45°
2" Diameter
1/8" x 45°
1/16" x 45°
1.5" Diameter
1/4" x 45°
.125"
.125"
.1856"
2 1/2"
1.264"
.118"
.072"
1 3/4"
1.500"
2 1/8"
4.000"

1. 1/8" x 45° chamfer — — — —

2. 1/16" x 45° chamfer ___ ___ ___ ___

3. 1/4" x 45° chamfer ___ ___ ___ ___

4. 1.856" recess ___ ___ ___ ___

5. 1.264" recess ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency I31: Cut multiple threads.

JS 2.4

CUT/CHASE EXTERNAL, MULTIPLE AND ACME THREADS

Equipment:

Right-hand threading tool
Center gage
Steel rule, 6"
Lathe with chuck and tailstock center
Quick-change tool post and toolholders
Screw pitch gage
Cutting oil
Steel bar, SAE 1018, 2 1/2" diameter, 4" long
Wrenches for chuck, tool post and toolholders, and compound
Clean shop cloth
File

NOTE: The prepared workpiece from JS 2.3 can be used for this exercise, or the instructor may provide an alternate print and workpiece.

Procedure:

1. Check all oil levels and perform daily maintenance.

2. Chuck on 2" diameter of work. Set compound 30° to right of cross-feed for right-hand threads (30° to left for left-hand threads).

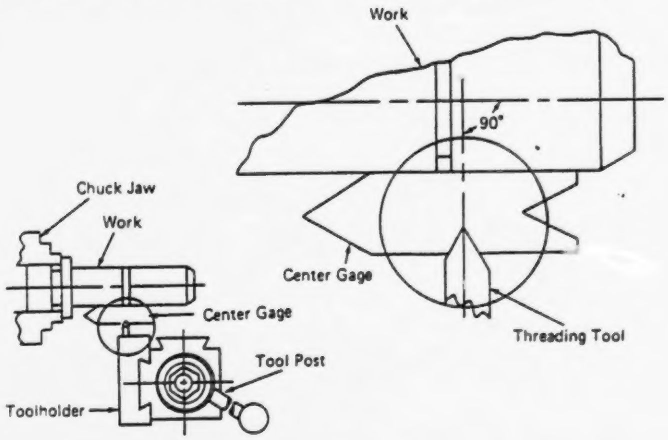
3. Set lathe speed at 80 rpm. Mount tool in toolholder and adjust to center height.

   NOTE: Threading is done at 1/4 of turning speed.

   EXAMPLE: Thread speed $= 1/4 \left[\frac{4 \times CS}{\text{Diameter}}\right] = 1/4 \left[\frac{4 \times 120}{1.5}\right] = 1/4 \{320\} = 80$ rpm

4. Loosen tool post and set tool square to axis of threads using center gage.

   NOTE: When aligning the tool, hold center gage parallel to center line of workpiece and tap the tool post until tool fits V-groove in center gage.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 430.

5. Set carriage controls to cut 12 threads per inch. (Consult operator's manual for control locations or ask the instructor for directions.)

6. Advance threading tool with cross-feed until point of tool is close to workpiece and cross-feed handwheel handle is at 11:00 position; zero the graduated collar.

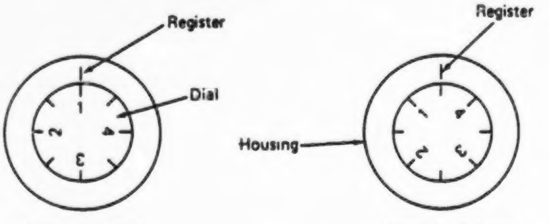
7. Start spindle and advance compound feed handwheel until cutting tool marks the work; move carriage so the tool is just to right of work. Zero graduated collar of compound.

8. Calculate compound depth of feed for 12 threads per inch when using compound feed.

   NOTE: Compound depth of feed is equal to .75 divided by the number of threads per inch. C = .75 ÷ N = .75 ÷ 12 = 0.0625"

9. Advance compound 0.003" and set half-nut lever to one of the lines on thread-chasing dial.

   NOTE: For even numbers of threads, the half nut can be engaged on numbered or unnumbered lines. For odd numbers of threads, the half-nut lever must be engaged on numbered lines only. The same line or number does not need to be used each time a cut is made.



Numbered Lines
1, 2, 3, & 4

Unnumbered Lines
1 1/2, 2 1/2, 3 1/2, & 4 1/2

Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 431.

10. Engage half-nut lever and apply cutting oil; allow carriage to move with lead screw until tool reaches recess.

11. Disengage half-nut lever and crank cross-feed to move tool away from work. Move carriage to right until tool clears end of work; turn cross-feed back to zero (original position).

12. Stop spindle and use a screw pitch gage or a center gage to check for the correct pitch.

13. Make any necessary adjustments. Start spindle and set depth of cut by advancing compound feed for the first cut; apply cutting oil.

    NOTE: Amount of feed for each cut should be less than previous cut. Plan to make 6-7 cuts. To clean threads, two cuts are made without advancing the tool.

14. Engage half-nut lever and allow tool to move to recess. Then disengage half-nut lever, crank cross-feed out of workpiece until tool is clear and move carriage to right until tool is past end.

15. Crank cross-feed in to zero and advance tool for next cut. Apply cutting oil and repeat cutting steps until total depth of feed is reached.

16. File burrs from top of thread and stop spindle. Use a test nut or other means to check size of threads.

    NOTE: If threads are to be cut to a particular class of fit, it is necessary to check the pitch diameter with a pitch micrometer or three-wires before making the finish cuts.

17. Turn part end-for-end and rechuck.

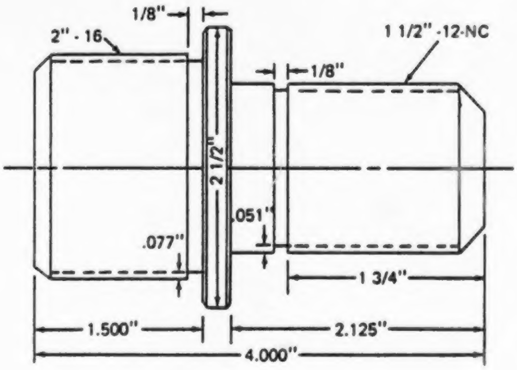
18. Repeat steps 6-17 to cut 16 threads per inch to other recess.

CAUTION: Care must be taken when cutting to a shoulder--if tool hits shoulder, it damages tool and workpiece and changes angle of tool.

19. Turn power off, clean machine and put away tools.

20. Turn in workpiece and job sheet to instructor.

Product evaluation



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 435.

	Evaluation			
Procedure:	3	2	1	N
1. Smoothness of 1 1/2" 12-thread	___	___	___	___
2. Nut fits threads	___	___	___	___
3. Threads cut to recess	___	___	___	___
4. Smoothness of 2" 16-thread	___	___	___	___
5. Nut fits threads	___	___	___	___
6. Threads cut to recess	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's final evaluation for competency I20, I31 and I32.

CUT/RECHASE INTERNAL THREADS

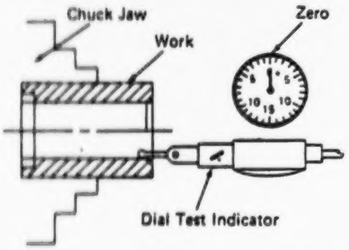
Equipment:

Lathe with four-jaw chuck	6" steel rule
Quick-change tool post and boring bar holder	Cutting oil
3/4" boring bar with threading tool	Thread plug gage or test bolt
Center gage	Dial test indicator and holder
	2" diameter steel bar, 2 1/4" long

Procedure:

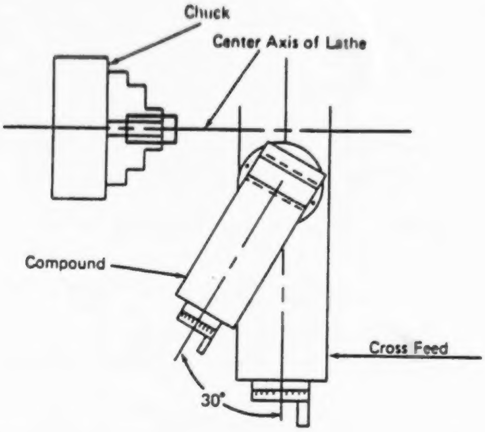
1. Check oil levels and perform daily maintenance.

2. Chuck part in four-jaw chuck and align bore in chuck with dial indicator. (Notice that the tapered portion faces out to provide easy entry of threading tool.)

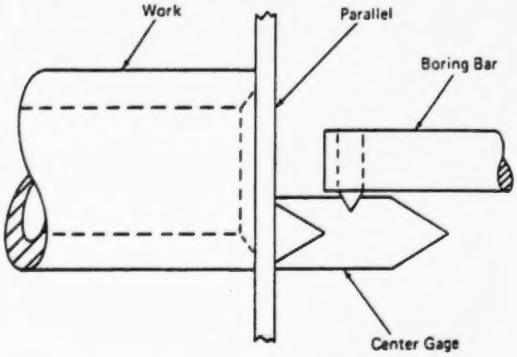

Chuck Jaw
Work
Zero
Dial Test Indicator

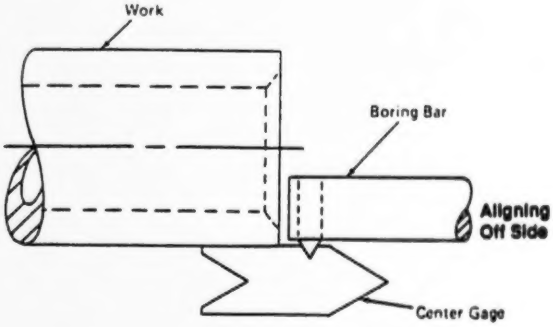
Art credit for this job sheet: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 441-447.

3. Set compound 30° to left of the cross-feed.


Chuck
Center Axis of Lathe
Compound
Cross Feed
30°

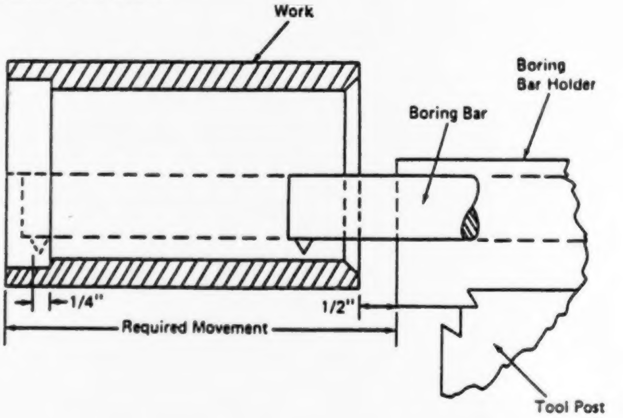
4. Mount boring bar on tool post and set to center height. Use center gage to align threading tool parallel to axis of bore.


Work
Parallel
Boring Bar
Center Gage


Work
Boring Bar
Aligning Off Side
Center Gage

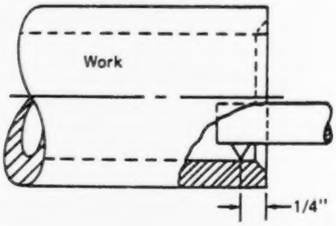
5. Set speed at approximately 85 rpm. Set carriage to cut 12 threads per inch. Advance cross-feed until boring bar clears bore, then move carriage to left to check for bar clearance and extension.

NOTE: The extension of the boring bar should be minimal to prevent spring. However, travel of the carriage must permit the boring bar to move 1/4" beyond the thread and still allow 1/2" clearance between workpiece and toolholder.


Work
Boring Bar Holder
Boring Bar
1/4"
1/2"
Required Movement
Tool Post

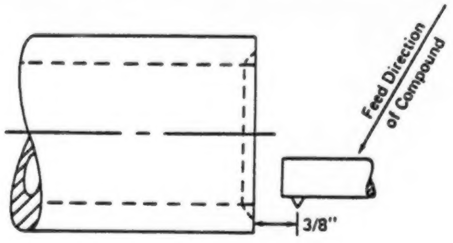
6. Move carriage to right until point of threading tool is 1/4" inside bore. Start spindle, turn compound rest feed counter-clockwise to remove any slack in screw and set graduated collar.

7. Crank cross-feed counter-clockwise until tool just starts to cut on bore; zero graduated collar of cross-feed.



8. Move carriage to right until boring bar clears end of workpiece 3/8", then crank compound rest feed counter-clockwise to feed tool 0.020".

   NOTE: Most graduated collars on compounds are graduated 1:1; because you are turning counter-clockwise, the reading should be on 80 if 100 equals one revolution of graduated collar.



9. Put cutting oil in bore, engage half-nut lever and allow tool to move to left until point of tool clears left end of work.

10. Disengage half nut, crank cross-feed clockwise about one revolution, move carriage to right until tool clears end and crank cross-feed to zero setting.

11. Repeat steps 8-10 to produce second cut.

12. To clean threads, repeat steps 9 and 10 to produce cut without feed.

    NOTE: The cut produced during this step is due to the spring of the boring bar.

13. Advance tool 0.010" and repeat steps 9 and 10. To clean threads, repeat steps 9 and 10 without advancing tool.

14. Repeat steps 8-10 to make three cuts with depths of 0.005", 0.002" and 0.002, as well as one of two cuts with no advancement.

    NOTE: The compound feed for 12 threads per inch is 0.063 (.75 ÷ N). Following these steps, the compound will be fed 0.059".

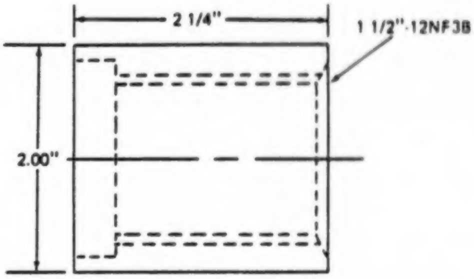
15. Stop machine and clean threads; check threads with test bolt or thread plug gage 1 1/2-12 NF. (Use test bolt.)

16. Continue to make cuts of 0.001" until bolt or gage screws in properly.

    NOTE: If last cuts are made too heavily, thread diameter will be tapered; correct by making cuts without advancing compound.

17. Turn off power, clean machine and put away tools. Turn in workpiece to instructor.

Product evaluation:



	Evaluation			
	3	2	1	N
1. Fit on test bolt	___	___	___	___
2. Class three fit	___	___	___	___
3. Smoothness of threads	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's final evaluation for competency I21: Cut/rechase internal threads.

JS 2.6

CHASE/RECHASE METRIC THREADS

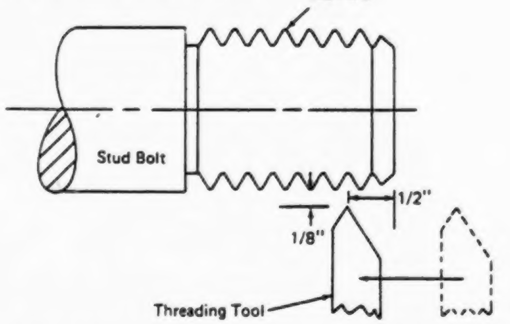
Equipment:

Right-hand threading tool
Center gage
6" steel rule
Lathe with four-jaw chuck
Quick-change tool post and toolholder
Threaded stud, M24 x 3 or selected size (Instructor will provide metric thread.)

NOTE: This procedure may be required on a bolt that has damaged threads or when a threading tool is removed, sharpened and put back in toolholder.

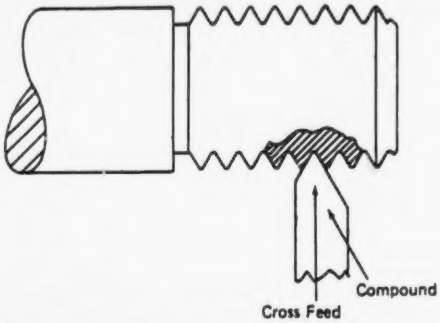
	Evaluation			
Procedure:	3	2	1	N
1. Check all oil levels and perform daily maintenance.	___	___	___	___
2. Set compound 30° to right of cross-feed. Set lathe speed. Chuck bolt and align.	___	___	___	___
3. Mount threading tool in toolholder, adjust center height and use center gage to square tool to axis of bolt. Set carriage controls to cut metric M24 x 3.	___	___	___	___
4. Move carriage to right so that tool clears end of bolt 1/8" from work. Start spindle and engage half-nut lever; allow tool to travel to left until it is about 1/2" to the left of the bolt's end; stop spindle.	___	___	___	___

NOTE: Do not disengage the half-nut lever yet.



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 438.

5. Advance tool by moving cross-feed and compound until tool fits in V-groove of thread. (When picking up threads, you may want to place a piece of paper between the bed and workpiece to help reflect light.) — — — —



Credit: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 438.

6. Zero both graduated collars and back tool out of threads with cross-feed; disengage half-nut lever. — — — —

7. Move tool to right with carriage handwheel until tool clears end of workpiece about 1/4"; turn cross-feed to zero. — — — —

8. Start spindle, engage half-nut lever and allow tool to move through threads to recess; disengage half-nut and clear tool. — — — —

9. Stop spindle and check with test nut; if necessary, make one or more cuts after feeding compound 0.001"; check with test nut each time. — — — —

10. Ask instructor to check procedure. — — — —

11. Clean machine and put away tools. — — — —

Average of above evaluations* — — — —

*This average is the student's final evaluation for competency I22: Chase metric threads.

USE COMPOUND REST TO CUT SHORT EXTERNAL TAPERED SURFACE

Equipment:

Right-hand turning tool
Facing tool
6" steel rule
Lathe with chuck
Quick-change tool post and toolholders
Wrenches for chuck, tool post, toolholder and compound
Cutting oil
1 1/8" diameter hex steel bar, SAE 1018, 4 1/8" long (A 1 1/8" round steel bar can be substituted.)
Clean shop cloth

Procedure:

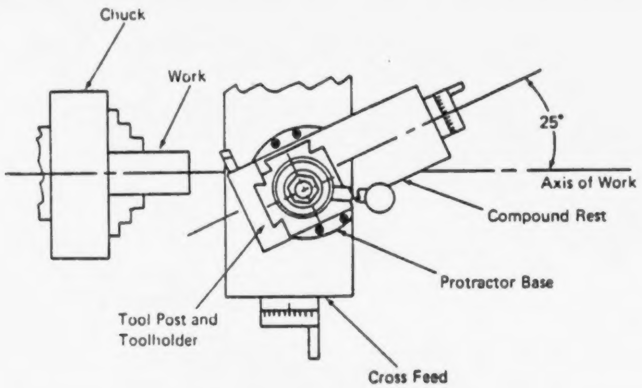
1. Check oil levels and perform daily maintenance.

2. Chuck workpiece with about 2" protruding from end of chuck jaw. Face end smooth.

3. Set speed at 425 rpm. Loosen compound rest lock nuts and set compound at a 25° angle to axis of work.

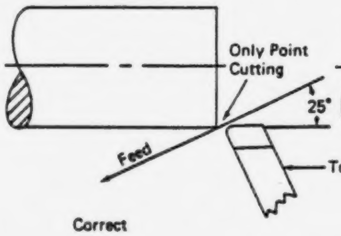
   CAUTION: When cutting angles (tapers) with the compound, it is recommended to cut toward the chuck to keep hands away from the revolving chuck.

   NOTE: Depending on the zero reference of the protractor base of the compound, the reading will be 25° or 65°.

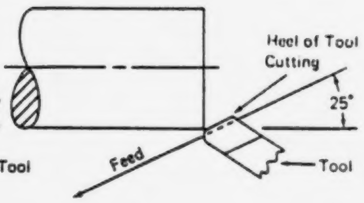


Art credit for this job sheet: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 410-413.

4. Set tool to center height. Position tool so that only the point makes contact with workpiece when tool is fed along the angular setting of compound; place tool near end of work.



Correct



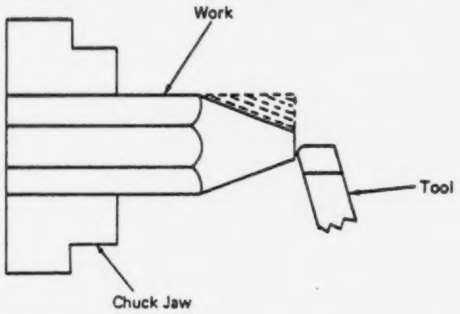
Incorrect

5. Lock tool post and toolholder in place. Turn on lathe and start spindle.

6. Apply cutting oil as required during cutting; advance tool 0.150" with the cross-feed; feed tool into work, using compound handwheel with a slow, continuous motion until tool stops cutting. Crank tool back with same motion until it clears work.

   NOTE: Turning the compound with both hands in a continuous motion gives a smooth finish without feed marks because there is pressure on the tool at all times.

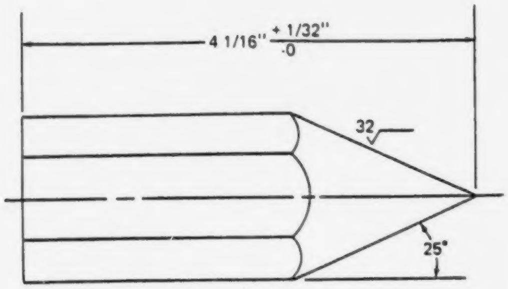
7. Continue this process until the workpiece comes to a point.



8. Clean machine and put away all tools.

9. Turn in workpiece to instructor.

Product evaluation:



	Evaluation 3	2	1	N
1. Measurement of angle 25° ± 30'	_	_	_	_
2. Measurement of overall length (4 1/16" + 1/32 - 0.0)	_	_	_	_

3. Finish of machined surface, #32 ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's final evaluation for competency I23: Use compound rest to cut short external tapered surface.

JS 2.8

CUT TAPERS BY OFFSET TAILSTOCK

Equipment:

Workpiece, 1" diameter by 12" length
Dial indicator with base
Drive dog
Drive plate
Rotating center
Dead center with sleeve
Allen wrenches
Adjustable wrench
Lathe tool (right-hand and left-hand)
1" micrometer

NOTE: Set tailstock toward operator .250" ± .005"; cut taper length 8".

Procedure:	Evaluation 3	 2	 1	 N
1. Prepare workpiece for turning between centers. Mount workpiece between centers.	___	___	___	___
2. Turn all parallel diameters and faces.	___	___	___	___
3. Calculate tailstock setover (D - d + L where D = large-end diameter, d = small-end diameter and L = length).	___	___	___	___

NOTE: This setover allows an approximate first setting to be made. Final adjustment is made by checking workpiece with a taper gage.

4. Set over tailstock.	___	___	___	___

a. Remove workpiece from centers.

b. Release tailstock clamp and lightly tighten.

c. Release locking screw on rear face of tailstock.

d. Position a dial indicator to indicate amount of setover.

e. Adjust the two opposing set screws in side faces of tailstock base to offset the tailstock the calculated amount as read on dial indicator.

NOTE: Adjust tailstock toward tool to turn taper smaller at tailstock end.

f. Tighten loose screw. Tighten rear lock screw. Fully tighten tailstock clamp.

5. Remount workpiece between centers.	___	___	___	___

6. Turn taper. (Proceed as for normal parallel turning. Cuts taken must be light, otherwise the offset tailstock center will damage the workpiece center.) ___ ___ ___ ___

   a. Take roughing cuts to produce a taper long enough to be checked by a gage.

   b. Adjust tailstock as necessary. Take light cut and recheck.

   c. Finish turn tapered diameter.

   NOTE: The taper as set will be reproduced on successive workpieces only if the length between workpiece centers remains constant.

7. Reset tailstock to spindle centerline. ___ ___ ___ ___

8. Clean machine and put away all tools. ___ ___ ___ ___

9. Turn in workpiece to instructor. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's final evaluation for competency I24: Cut tapers by offset tailstock.

251

JS 2.9

CUT EXTERNAL AND INTERNAL TAPERED SURFACES WITH TAPER ATTACHMENT

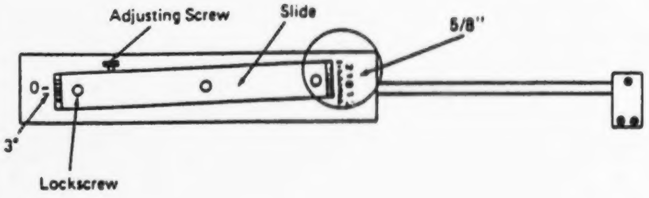
Equipment:

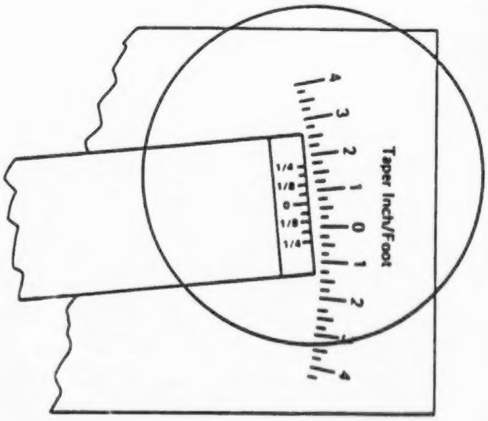
Right-hand turning tool
Steel rule, 6"
Live center
Spindle adapter
Drive plate
Ball-bearing center for tailstock
Quick-change tool post and toolholder
Bent-tail lathe dog or clamping lathe dog and wrenches
Wrenches for tool post, compound, carriage stop and taper attachment
Lubricating oil
Dial indicator, 0.250" range
Clean shop cloth
Morse taper gage, #4
Micrometer, 1-2"
Lathe with taper attachment and carriage stop
Spacer, 2"
Cutting oil
Prussian blue
Steel part, 1 1/2" diameter and 7" long, faced and center-drilled on both ends
Boring bar
Three-jaw chuck
1" twist drill

NOTE: A three-jaw chuck will be used to secure workpiece during internal taper operation.

	Evaluation			
Procedure:	3	2	1	N
1. Check all oil levels and perform daily maintenance. Set up lathe to turn between centers with drive plate. Place lathe dog on large end of workpiece (end not machined); place workpiece between centers and adjust.	___	___	___	___
2. Clean taper attachment with clean shop towel and apply a thin coat of lubricating oil. Mount taper attachment on lathe. Loosen lock screws on each end of attachment. Adjust attachment to almost 5/8" per foot by turning adjusting screw.	___	___	___	___

NOTE: The taper of the plug gage is 0.6232" per foot. Set the taper attachment just short of 5/8" (0.625"). This should be done so that the right end of the taper attachment slide moves away from the operator because the large end of the taper is at the headstock.

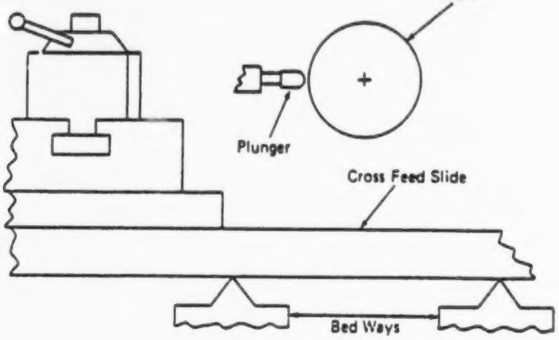




Art credit for this job sheet: Dunn, James. Machine Shop Lathes. Stillwater: Curriculum and Instructional Materials Center, Oklahoma State Board of Vocational and Technical Education, 1983, pg. 400, 401, 403-405, 407.

3. Tighten lock screws and check taper with dial indicator.

   a. Mount dial indicator on tool post; put plunger of dial indicator on center height with plunger parallel to cross-feed.



   b. Position taper attachment so that carriage can travel to right, past end of work; then clamp tailstock to bed with locking screws.

   c. Move carriage to left until indicator plunger is about 1/4" from end of work.

   d. Advance cross slide until indicator needle has moved 0.125"; move carriage by hand to left until indicator needle starts to move, then stop.

   e. Zero indicator dial by turning face of indicator.

   f. Place 2" spacer between carriage and carriage stop; lock carriage stop in place.

   NOTE: Travel dial, dial indicator (way-indicator) or dial of carriage can also be used to indicate when the carriage has moved 2" to the left.

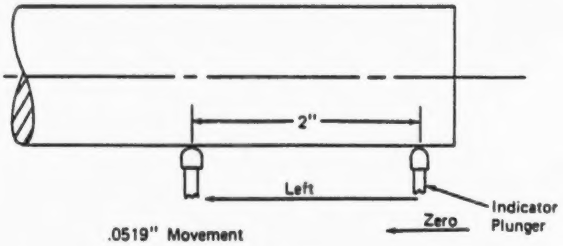
   g. Move carriage to the left until carriage stop is reached; observe movement of indicator.

NOTE: The dial indicator measures the offset of only one side of the taper. Therefore, the amount indicated would be one-half of the taper required for the distance of indicator travel--2" in this case. To determine the amount of taper required in the 2" distance, use the formula to convert taper per foot to taper per inch. Divide by two to find the total taper for the 2" distance.

tpi = tpf + 12 = 0.6232 + 12 = 0.0519"

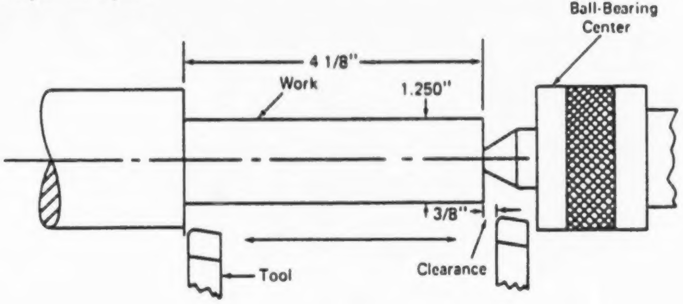
NOTE: A taper for the 2" distance would be twice the tpi (0.1038"). Because the indicator measures only one side of the taper, indicator movement over a 2" distance would be one-half the total taper for that distance.

Indicator movement = 1/2 x taper for distance = 1/2 x 0.1038" = 0.0519"



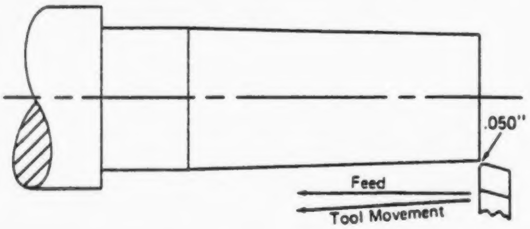
h. Continue adjusting taper attachment until movement of indicator is between 0.051" and 0.052". Remove dial indicator.

4. Set speed at 288 rpm; set feed at 0.010 ipr. Mount turning tool in tool post and set to center height. Check that carriage moves to left so that tool will cut to shoulder; move carriage to right so that tool clears workpiece about 3/8" to 1/2". — — — —



5. Move tool back to left so that it is about 1/4" from end. Turn on lathe and start spindle; advance tool until it starts to shave work; stop and zero cross-feed. — — — —

6. Move carriage to right to clear tool and advance the cross-feed to move tool in to a depth of 0.050"; engage carriage power feed and allow tool to cut until it stops cutting; apply cutting oil as required during cutting.



7. Stop power feed and move carriage to right until tool clears end of work; advance tool another 0.015".

8. Increase speed to 400 rpm, decrease feed to 0.005 ipr and make another cut; then move tool right to clear work.

9. Stop machine, remove workpiece from centers and apply a thin coat of Prussian blue.

10. Slide workpiece into #4 plug gage or #4 taper of lathe tailstock; rotate with hand and remove.

NOTE: If taper is set correctly, rotation should mark the circumference of the taper along its full length.

11. Make any necessary adjustments. Put workpiece back between centers; measure at 1/8" from small end of taper with micrometer (should be 1.042" ± 0.001").

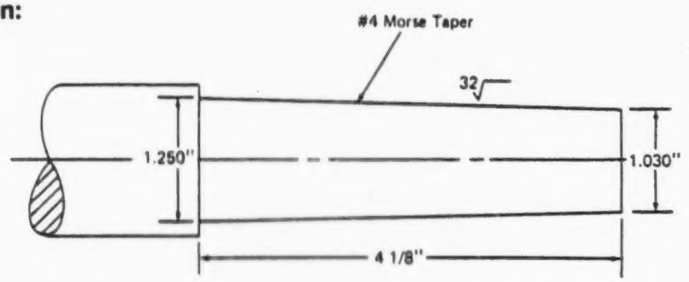
12. Determine amount to be removed, advance tool as required and make finish cut.

13. Stop spindle, check taper and cut again if required. Place workpiece in three-jaw chuck opposite end and cut internal tapered surface per instructor directions.

14. Clean machine and put away all tools.

15. Turn in part to instructor for evaluation.

Product evaluation:



1. Length of taper (4 1/8" + 1/64" - 0.0)

2. Large diameter (1.250" ± 0.002") ___ ___ ___ ___

3. Small diameter (1.030" ± 0.002") ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's final evaluation for competencies I25 and I26.

USE FORM TOOLING, POLISH WORKPIECE AND PERFORM LATHE FILING

Equipment:

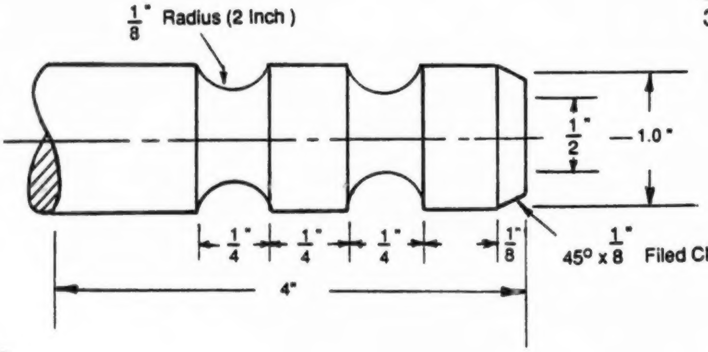
1/8" radius nose lathe tool bit (1" x 3" crs)
Single-cut lathe file with handle
Three-jaw chuck
Emery cloth

NOTE: Obtain 1" diameter workpiece and perform all three tasks on one set-up.

Procedure:

1. Clamp workpiece into three-jaw chuck. Using forming tool, lightly face end of workpiece.
2. Set forming tool perpendicular to axis of workpiece. Set rpm 1/4-1/2 turning rpm and cut each 1/8" radius to depth.
3. Using lathe file, chamfer 1/8 x 45° end.
4. Using emery cloth, polish diameters and chamfered end of workpiece.
5. Stop spindle, check workpiece and cut again if required.
6. Clean machine and put away all tools.

Product evaluation:



	Evaluation			
	3	2	1	N
1. Form tool cuts	___	___	___	___
2. Form finish	___	___	___	___
3. Filed chamfer	___	___	___	___
4. Finish with emery #16	___	___	___	___
Average of above evaluations*	___	___	___	___

*This average is the student's final evaluation for competencies I28, I29 and I33.